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(NASA-CR-151895) EDIN DESIGN STUDY
ALTERNATE SPACE SHUTTLE BOOSTER REPLACEMENT
CONCEPTS. VOLUME 2: DESIGN SIMULATION
RESULTS Interim Report (Sigma Corp.,
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EDIN DESIGN STUDY
ALTERNATE SPACE SHUTTLE BOOSTER
REPLACEMENT CONCEPTS
VOLUME II - DESIGN SIMULATION RESULTS



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Prepared for:

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Houston, Texas 77058
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FOREWORD

This report is a technical assessment of a Shuttle-based launch system consisting of the Shuttle Orbiter, the external tank, and a recoverable liquid rocket booster system replacing the solid rocket booster system. This report was prepared for Johnson Space Center under Contract NAS9-14520. This study was conducted under the direction of Mr. Robert W. Abel, the technical monitor and H. P. Davis, chief of the Future Programs Office.

Compilation and publication of this assessment involved the time, effort and cooperation of a number of organizations and individuals. NASA personnel directed the study and defined design requirements and constraints. The actual computations and the majority of analysis used to generate the report were provided by the Sigma Corporation. Willie E. Heineman of EW2 checked vehicle weights and provided a number of the weight algorithms.

INTRODUCTION

The use of a recoverable liquid rocket booster (LRB) system to replace the existing solid rocket booster (SRB) system for the Shuttle offers the potential of extending the payload capability and of cost saving by recovery and re-use of the LRB with a minimum of refurbishment cost. The concept uses the basic Orbiter modified to include a weight penalty to account for the additional structure necessary to accommodate the increased payload and the Shuttle ET modified to account for deletion of the SRB/ET attachments and scaled according to a constant mass fraction. Some modification of the ET would be required to take thrust loads longitudinally along the tank rather than laterally through the tank. Two different types of LRB were investigated. One consisted of three and four up-rated F-1 engines, while the other was powered by high-pressure LOX/RP engines based on those proposed by Mr. Rudi Beichel of Systems Development Corporation. The LRB is mounted aft of the ET and is jettisoned at booster engine cut-off (BECO) and recovered for re-use.

The present study, designated EDIN05, was initiated for the purpose of assessing this LRB concept. The study, based on information contained in References 1 through 6, was performed using EDIN software and hardware and represents a joint effort between NASA and Sigma Corporation. The NASA Engineering Analysis Division and the Future Programs Office were involved in defining design requirements and constraints. Sigma Corporation developed the simulation procedures and supported the engineering analysis and computations.

Historical weight estimating relationships were developed for the LRB using Saturn technology and modified as required to support the EDIN05 study. Mission performance was computed using February 1975 Shuttle configuration groundrules to allow reasonable comparison of the existing Shuttle with the EDIN05 designs. The launch trajectory was constrained to pass through both the RTLS/AOA and main engine cut-off (MECO) points of the Shuttle Reference Mission 1. Performance analysis is based on a point design trajectory model which optimizes initial tilt rate and exo-atmospheric pitch profile. A gravity turn was employed during the boost phase in place of the Shuttle angle-of-attack profile. Engine throttling add/or shutdown was used to constrain dynamic pressure and/or longitudinal acceleration where necessary. Four basic configurations were investigated: a parallel-burn vehicle with an F-1 engine-powered LRB; a parallel-burn vehicle with a high-pressure engine-powered LRB; a series-burn vehicle with

a high-pressure engine-powered LRB. The relative sizes of the LRB and the ET are optimized to minimize GLOW in most cases.

This report comprises two volumes. Volume I contains an engineering analysis of each simulation performed, a description of the simulation programs and procedures, and a discussion of the LRB weight estimating relationships. Volume II presents the detailed results of the simulations, including weight statements, trajectory plots, and mass properties breakdowns.

DISCUSSION OF RESULTS

Configuration Descriptions

Four basic configurations were investigated in the EDIN05 design series:

1. A parallel burn vehicle with an F-1 engine-powered LRB.
2. A parallel burn vehicle with a high-pressure engine powered LRB.
3. A series burn vehicle with an F-1 engine-powered LRB.
4. A series burn vehicle with a high-pressure engine-powered LRB.

The EDIN05 study series comprised ten individual design simulations, which are briefly described below.

STUDY NO.

EDIN0501	LRB sized for three F-1, ET resized to minimize GLOW for 100K up-payload; parallel burn.
EDIN0502A	EDIN0501 LRB modified for seven 680K sea-level thrust high - Pc engine propulsion system, EDIN0501 ET, maximum payload determined, parallel burn.
EDIN0502B	EDIN0502A LRB, ET resized to maximize payload, parallel burn.
EDIN0503	EDIN0501 LRB modified for six 800K sea-level thrust high-Pc engine propulsion system, EDIN0501 ET maximum payload determined; parallel burn.
EDIN0504	LRB sized for optimum T/W using rubber high-Pc engines based on 800K Beichel, ET resized to minimize GLOW for 140K up-payload; parallel burn.
EDIN0504A	LRB sized for optimum T/W using rubber high-Pc engines based on 800K Beichel, ET resized to minimize GLOW for 150K up-payload; parallel burn.
EDIN0504B	EDIN0504A LRB modified for three F-1, EDIN0504A ET, maximum payload determined; parallel burn.
EDIN0504C	LRB sized for optimum T/W using rubber high-Pc engines based on 800K Beichel, ET resized to minimize GLOW for 150K up-payload; series burn.
EDIN0504D	EDIN0504C LRB modified for four F-1, EDIN0504C ET, maximum payload determined; parallel burn.
EDIN0505	LRB sized for four F-1, ET resized to minimize GLOW for 100K up-payload; series burn.

EDIN05 RESULTS SUMMARY

	SHUTTLE	501	502A	502B	503	504	504A	504B	504C	504D	505
LRB	SRB	Sized for 3 F-1	501 w/ (7) 680K Hi-Pc	501 w/ (6) 800K Hi-Pc	501 w/ (6) 800K Hi-Pc	Sized for opt. T/W Hi-Pc	Sized for opt. T/W Hi-Pc	504A w/ 3 F-1	Sized for opt. T/W Hi-Pc	504C w/ 4 F-1	Sized for 4 F-1
ET	-	R	501	R	501	R	R	504A	R	504C	R
PL	65K	100K	D	M	D	140K	150K	D	150K	D	100K
TYPE	P	P	P	P	P	P	P	P	S	S	S
GLOW	4.203M	4.835M	4.817M	4.928M	4.698M	4.261M	4.804M	4.598M	4.587M	4.344M	4.795M
T/W	1.491	1.240	1.236	1.209	1.283	1.236	1.350	1.308	1.345	1.479	1.340
LRB LIFT-OFF	2.327M	2.760M	2.693M	2.693M	2.569M	2.055M	2.562M	2.428M	2.898M	2.760M	3.186M
LRB PROPELLANT	2.019M	2.506M	2.459M	2.459M	2.335M	1.855M	2.333M	2.180M	2.642M	2.468M	2.919M
LRB INERT	309K	254K	234K	234K	234K	200K	228K	248K	256K	292K	265K
ET LIFT-OFF	1.626M	1.805M	1.805M	1.911M	1.805M	1.879M	1.905M	1.905M	1.351M	1.324M	1.322M
ET PROPELLANT	1.540M	1.707M	1.707M	1.807M	1.707M	1.777M	1.801M	1.801M	1.276M	1.248M	1.251M
ET INERT	86.3K	98.0K	98.0K	104.1K	98.0K	102.5K	103.9K	103.9K	75.2K	75.2K	73.0K
PAYLOAD	65K	100K	132K	137K	136K	140K	150K	78.5K	150K	73.3K	100K

D - Determined
 M - Maximized
 P - Parallel Burn
 R - Resized
 S - Series Burn

SIGMA CORPORATION

EDIN0501 DESIGN

SIMULATION RESULTS

FORECASTER: EDIN DESIGN CENTER DATE: 22 SEP 75
AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC TIME: 19:06
STUDY NO: EDIN0501

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING THREE F-1
ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR REPLACEMENT
OF THE SOLID ROCKET BOOSTERS.

MISSION: 100000.0 LB PAYLOAD
DUE EAST LAUNCH FROM ETR
A 250 FPS OMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL
MILE REFERENCE ORBIT.
A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED EXO-ATMOSPHERIC PITCH
PROFILE AND INITIAL TILT RATE.
MID POINT CONSTRAINT = SHUTTLE MISSION 1 RTLS/ADR
END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
ATMOSPHERIC INFIGHT CONSTRAINTS CONTROLLED BY ONE F1
ENGINE SHUTDOWN AND/OR SSME THROTTLING.
MAX DYNAMIC PRESSURE = 650.0 PSF
MAX ACCELERATION = 3.0 G

PROPULSION: LRB: THREE F-1 ENGINES RATED AS FOLLOWS:

THRUST(SL) = 1606788.5 LBS
THRUST(VAC) = 1748060.0 LBS
ISP(SL) = 266.01 SEC.
ISP(VAC) = 289.40 SEC.
FLOWRATE = 6040.2 LB/SEC
EXIT AREA = 66.763 SQ FT
MIX RATIO = 2.27:1

ORIGINAL PAGE IS
OF POOR QUALITY

ORBITER: THREE SSME ENGINES RATED AS FOLLOWS:

THRUST(SL) = 375000.00 LBS
THRUST(VAC) = 470000.00 LBS
THROTTLE = 1.09 TO .500
ISP(SL) = 363.20 SEC
ISP(VAC) = 455.20 SEC
FLOWRATE = 1032.5 LB/SEC
EXIT AREA = 44.896 SQ FT
MIX RATIO = 6.00:1

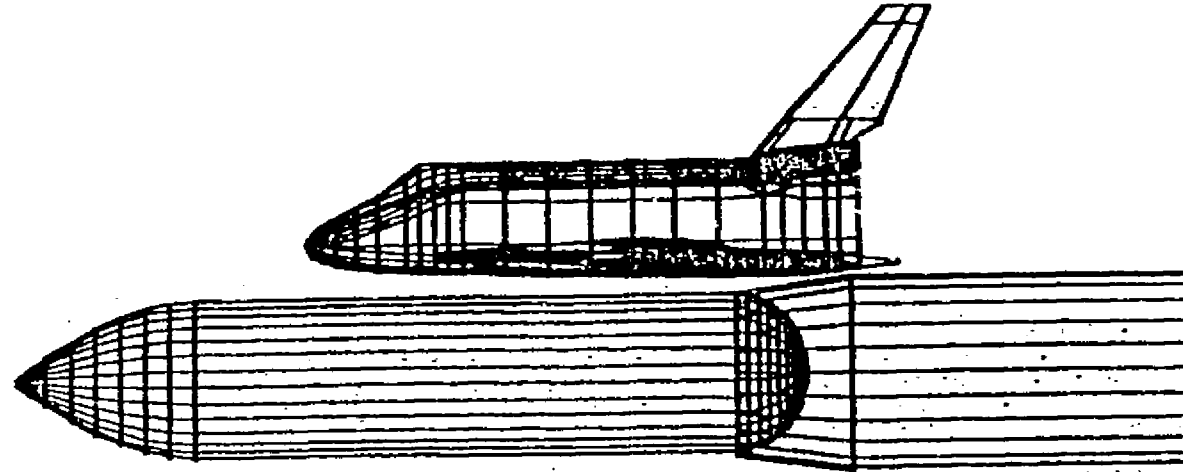
AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION
WERE OBTAINED FROM SHUTTLE AERO ESTIMATES. ADJUSTMENTS
WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
REF AREA = 2557.0 SQ FT

STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS
ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND
INCREASED UP PAYLOADS.

MASS PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC
ASSUMPTIONS.

LRB: WERS BASED ON SATURN TECHNOLOGY.
ET: FIXED MASS FRACTION DISTRIBUTED IN
ACCORDANCE WITH SHUTTLE ET WEIGHT
STATEMENT.
ORBITER: FEB 1975 SHUTTLE WITH MODS FOR
INCREASED UP PAYLOAD.

EDIN0501 DESIGN SIMULATION RESULTS



WEIGHTS SUMMARY REPORT

GLOW		4852515.12
ET LIFT-OFF WEIGHT		1805486.73
ET INERT WEIGHT	98039.18	
ET PROPELLANT	1707527.58	
LRB LIFT-OFF WEIGHT		2759774.62
LRB INERT WEIGHT	254013.13	
LRB PROPELLANT	2505710.76	
ORBITER LIFT-OFF WEIGHT		237254.00
ORBITER INERT WEIGHT	187254.00	
PAYLOAD	100000.00	

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	2362.	
BODY GROUP	43291.	
INDUCED ENVIRN PROTECT	19874.	
LANDING & AUX SYSTEMS	7683.	
PROPULSION-ASCENT	28054.	
PROPULSION-PCS	2657.	
PROPULSION-QMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2739.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 100K PAYLD	390.	
ORBITER EMPTY WEIGHT		151715.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	5024.	
PROPELLANT-PCS	6241.	
PROPELLANT-QMS	16149.	
ORBITER INERT WEIGHT		187254.
PAYLOAD		100000.
ORBITER PRELAUNCH WEIGHT		287254.

EXTERNAL TANK WEIGHT STATEMENT:

LOX TANK		16260.
BHD	79.	
FWD FRAME	51.	
FWD OGIVE	1342.	
AFT OGIVE	4511.	
XT 745 FRAME	313.	
BARREL	2917.	
INTERTANK FRAME	1064.	
AFT DOME	3469.	
SLOSH BAFFLES	2514.	
INTERTANK		12708.
MACHINED BARREL PNLS	5088.	
SK/STGR BARREL PNLS	3500.	
STABILIZING FRAMES(4)	1505.	
SRB THRST XT 985 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	68.	
BARREL PNLS SPLICES (8)	113.	
FRAME STABLIZERS	244.	
ET ASSY FASTENERS	191.	

LH2 TANK		39638.
FWD DOME	1902.	
XT 1129.9 FRAME	1877.	
BARREL NO.4	6525.	
XT 1377 FRAME	655.	
BARREL NO.3	6559.	
XT 1624 FRAME	655.	
BARREL NO.2	6563.	
XT 1871 FRAME	2056.	
BARREL NO.1	6942.	
XT 2058 FRAME	3929.	
AFT DOME	2225.	
THERMAL PROTECTION		7729.
LOX TANK	1657.	
INTERTANK	1720.	
LH2 TANK	4037.	
PROP (MECH+ELEC)	314.	
PROPULSION AND MECHANICAL SYSTEMS		4504.
LOX FEED SYS	1926.	
LOX ANTIGEYER SYS	181.	
LOX VENT SYS	101.	
LOX PRESS. SYS	219.	
LH2 FEED SYS	551.	
LH2 RECIR. SYS	36.	
LH2 VENT SYS	153.	
LH2 PRESS. SYS	162.	
HELIUM INJ. SYS	25.	
INTERTANK PURGE SYS	95.	
HAZARD GAS DETECTION SYS	10.	
FAIRINGS AND CONDUIT	407.	
LINE SUPTS. AND ATTACHS.	637.	
ELECTRICAL SYSTEM		278.
ET WIRING ASSY	188.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	17.	
CABLING ATTACHS.+SENSOR SUPTS.	73.	
ORB/SRB ATTACHMENTS		5358.
ORBITER SUPPORTS	3677.	
UMBILICAL BEAM	754.	
ORB/ET ATTACH FTGS	280.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL HDWR	647.	
MANUFACTURING VARIATION WT.		506.
EMPTY WEIGHT		87230.
UNUSABLE FLUIDS		486.
LH2 IN TANK	273.	
LH2 IN LINE	56.	
LOX IN LINE	157.	
PRE-PRESS.+INFLIGHT GASES		4405.
GH2	1145.	
GOX	3223.	
HELIUM	37.	
SEPARATION HARDWARE		6.
SRB SUPPORTS	0.	
ORB FITTINGS	6.	
FLT PERF RES		5912.
ET INERT WT		98039.
MAIN PROPELLANTS		1707448.
LOX	1463527.	
LH2	243921.	
ET LIFT-OFF WEIGHT		1805487.
MASS FRACTION		.9490

LIQUID ROCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		93058.
INTEGRAL LOX TANK	20679.	
INTEGRAL FUEL TANK	14022.	
INTERSTAGE	8583.	
AFT SKIRT	16159.	
THRUST STRUCTURE	33615.	
AERODYNAMIC SURFACES		8916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		2189.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1248.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		799.
ELECTRICAL SYSTEM	684.	
CONTROL SYSTEM	115.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		87977.
ENGINES (DRY)	57114.	
ACCESSORIES	416.	
GIMBAL SYSTEM	5283.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	8389.	
OXIDIZER SYSTEM	12419.	
SEPARATION AND RECOVERY SYSTEM		16665.
SEPARATION SYSTEM	2488.	
CHUTE SYS (MAIN AND DROGUE)	5724.	
FLOATATION SYSTEM	104.	
RECOVERY AIDS	102.	
FITTINGS AND SUPPORTS	197.	
RETRO SYS (100 F/S DEL V)	3174.	
REENTRY HEAT SHIELD	4876.	
STAGE DRY WEIGHT		209125.
CONTINGENCY		0.
EMPTY WEIGHT		209125.
PROPELLANT RESIDUALS		40575.
FUEL BIAS	1800.	
TRAPPED LOX TANK GASES	3871.	
TRAPPED FUEL TANK GASES	3440.	
FROST TRAPPED	434.	
TRAPPED FUEL	12958.	
TRAPPED LOX	18073.	
IN-FLIGHT LOSSES		4313.
FUEL LOSSES	2084.	
LOX LOSSES	2229.	
MAIN PROPELLANTS		2505762.
FUEL	766288.	
LOX	1739474.	
BLOW		2759775.
MASS FRACTION (BASED ON INERT WT)		.9080

ORBITER WT	287254.0
ET WEIGHT	1805486.7
LRB STAGE WT	2759774.7
GLOW	4852515.4
EFFECTIVE STG 1 LAMBDA	.92138
EFFECTIVE STG 2 LAMBDA	.92652

CONVERGENCE DATA:

GLOW	4852515.	
TARGET PAYLOAD	100000.	
ACTUAL PAYLOAD		99970.
PAYLOAD DELTA		-29.6
PAYLOAD BIAS		.0
TOTAL VIDEAL	30193.0	
STAGE 1 VIDEAL		9144.5
STAGE 2 VIDEAL		21048.5
TOTAL PROPELLANT	4213238.	
LRB PROPELLANT		2505711.
ET PROPELLANT		1707528.

STAGE 1 SIZING DATA

AVERAGE SP. IMP.	298.98
LIFT-OFF T/W	1.240
MAXIMUM Q	605.3
TIME AT MAX Q	80.0
STG 1 MAX LF	3.00
TIME AT MAX LF	132.8
EFF WDOT/EVENT 1	21460.9
EFF WDOT/EVENT 2	15456.7

STAGING CONDITIONS:

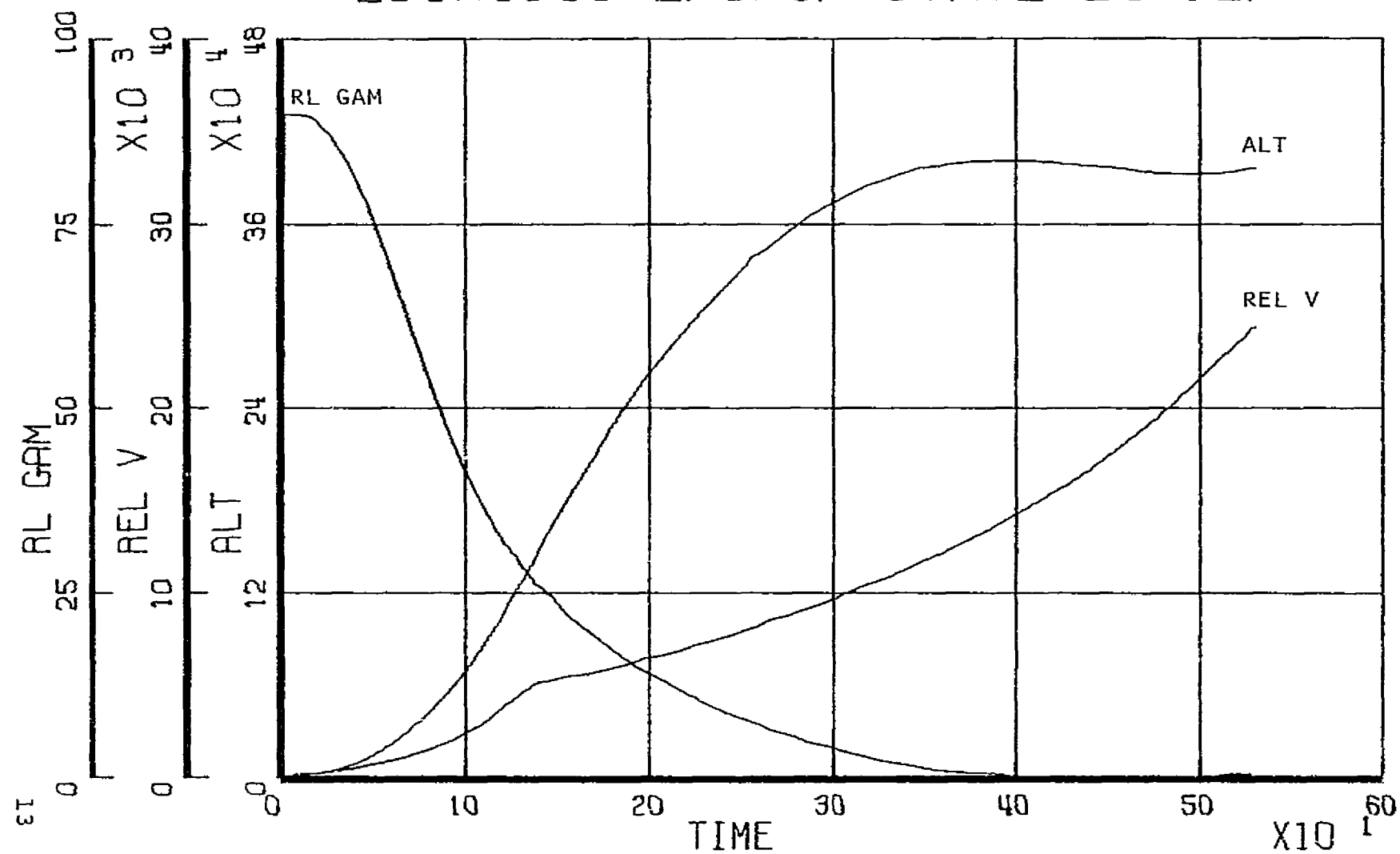
WEIGHT	1875506.
REL VELOCITY (FPS)	5136.7
REL F.P. ANGLE (DEG)	26.05
ALTITUDE (FT)	146941.
TIME (SEC)	141.02
ATT AFTER STG (DEG)	.92

MISSION SUMMARY: SEPTEMBER 18, 1975

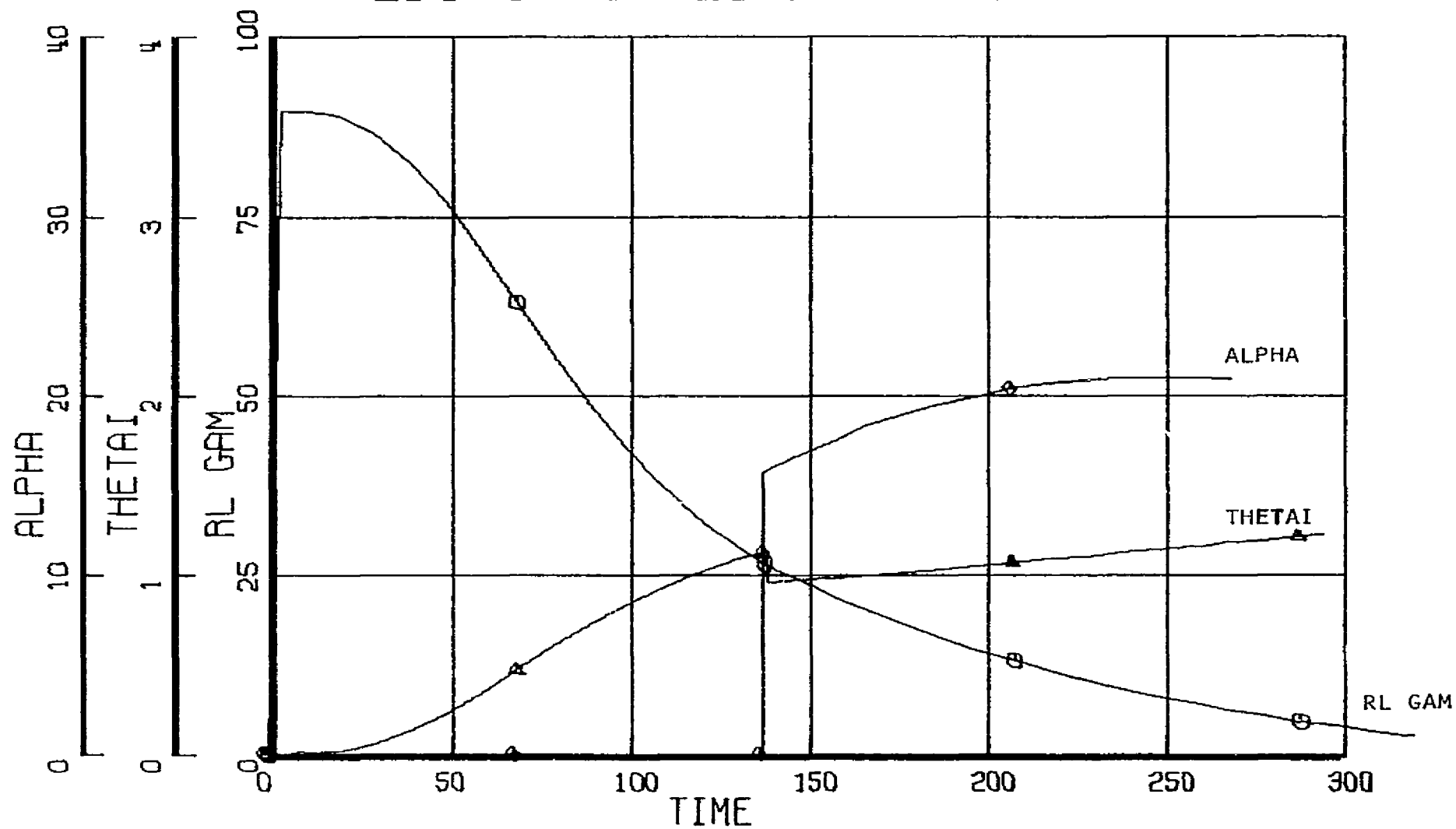
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4	EVENT 5
TIME (SEC)	132.8	141.0	262.4	532.0	513.7
ALTITUDE (K FT)	128.8	146.9	348.6	394.5	0
REL VELOCITY (100 FPS)	45.3	51.4	81.4	243.0	2.1
REL GAMMA (DEG)	28.6	26.0	8.27	.528	-99.8
WEIGHT (K LBS)	4852.5	2002.4	1621.5	1211.8	254.0
WEIGHT DROP (K LBS)	0	254.0	0	0	-
THROW WEIGHT (K LBS)	2002.4	1621.5	1211.8	385.26	-
CUM VIDEAL (100 FPS)		91.44	134.1	301.9	-
DOWNRANGE (NMI)	23.45	29.99	169.2	888.3	161.7

EVENT 1	ONE F-1 ENGINE SHUTDOWN	EVENT 3	RTLS/ADR CONSTRAINT
EVENT 2	BECD/SEPARATION	EVENT 4	MCCO/INJECTION
		EVENT 5	LRB TOUCHDOWN

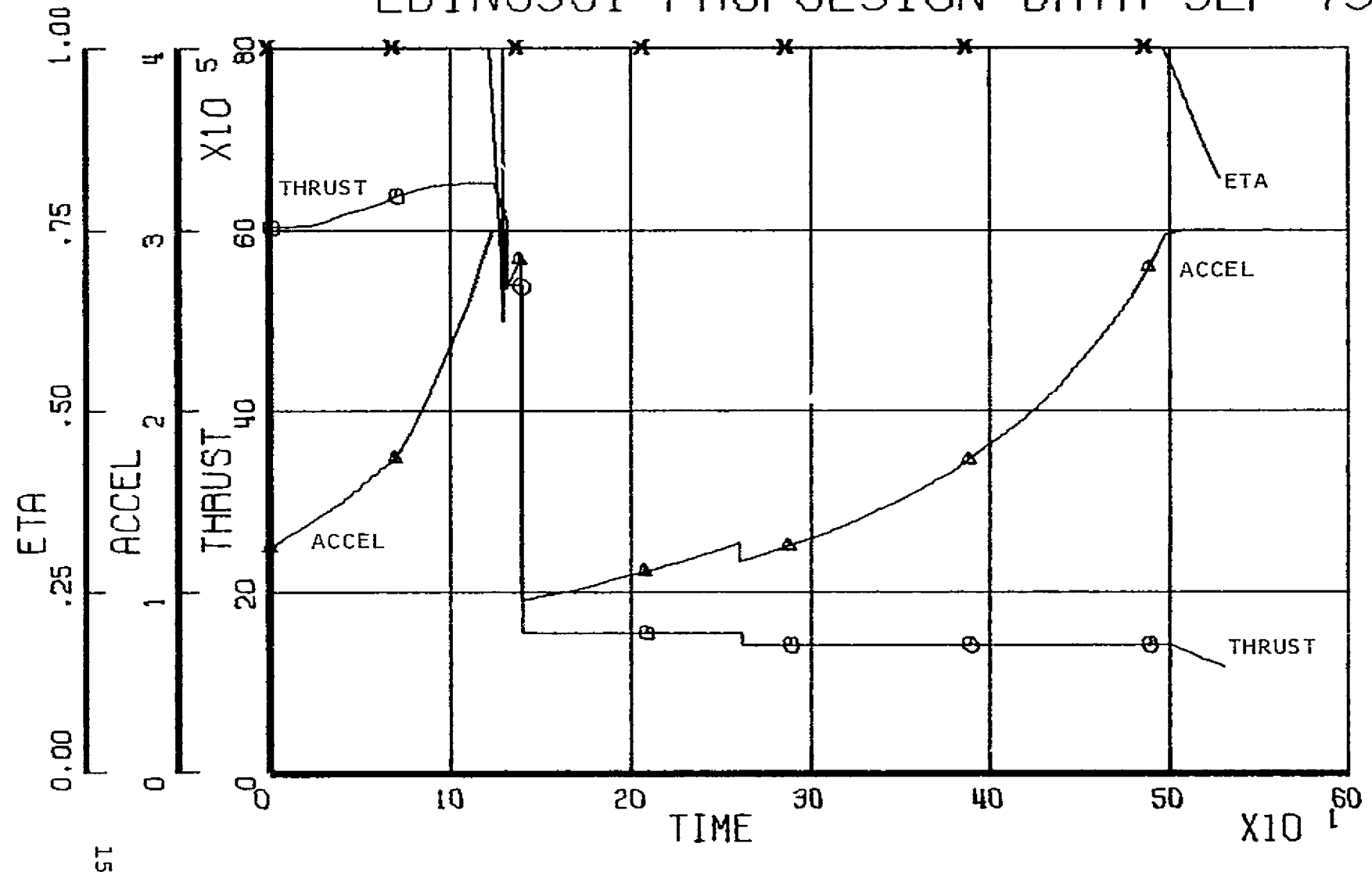
EDIN0501 LAUNCH STATE 24 SEP 75



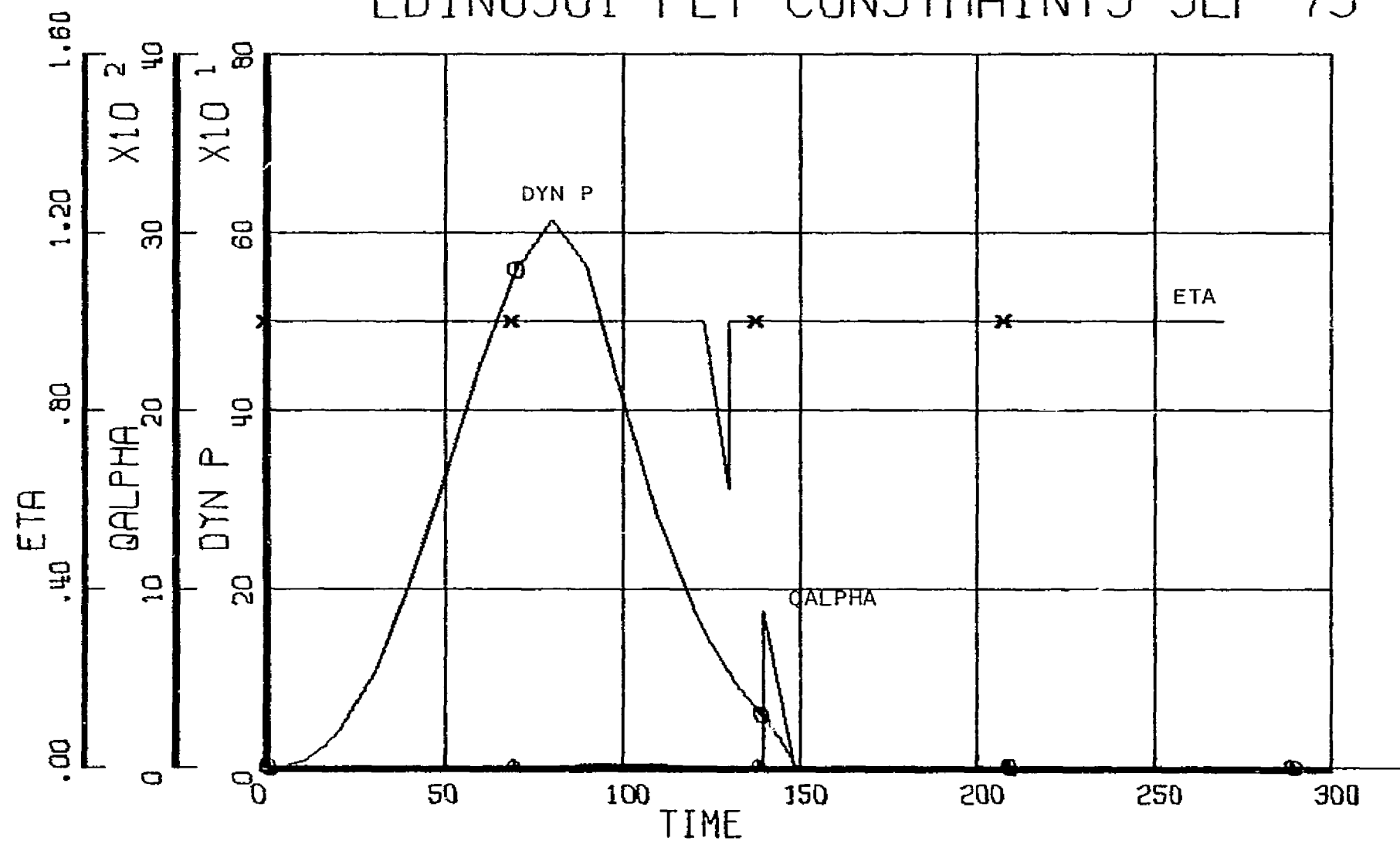
EDIN0501 FLIGHT ATTITUDE SEP 75



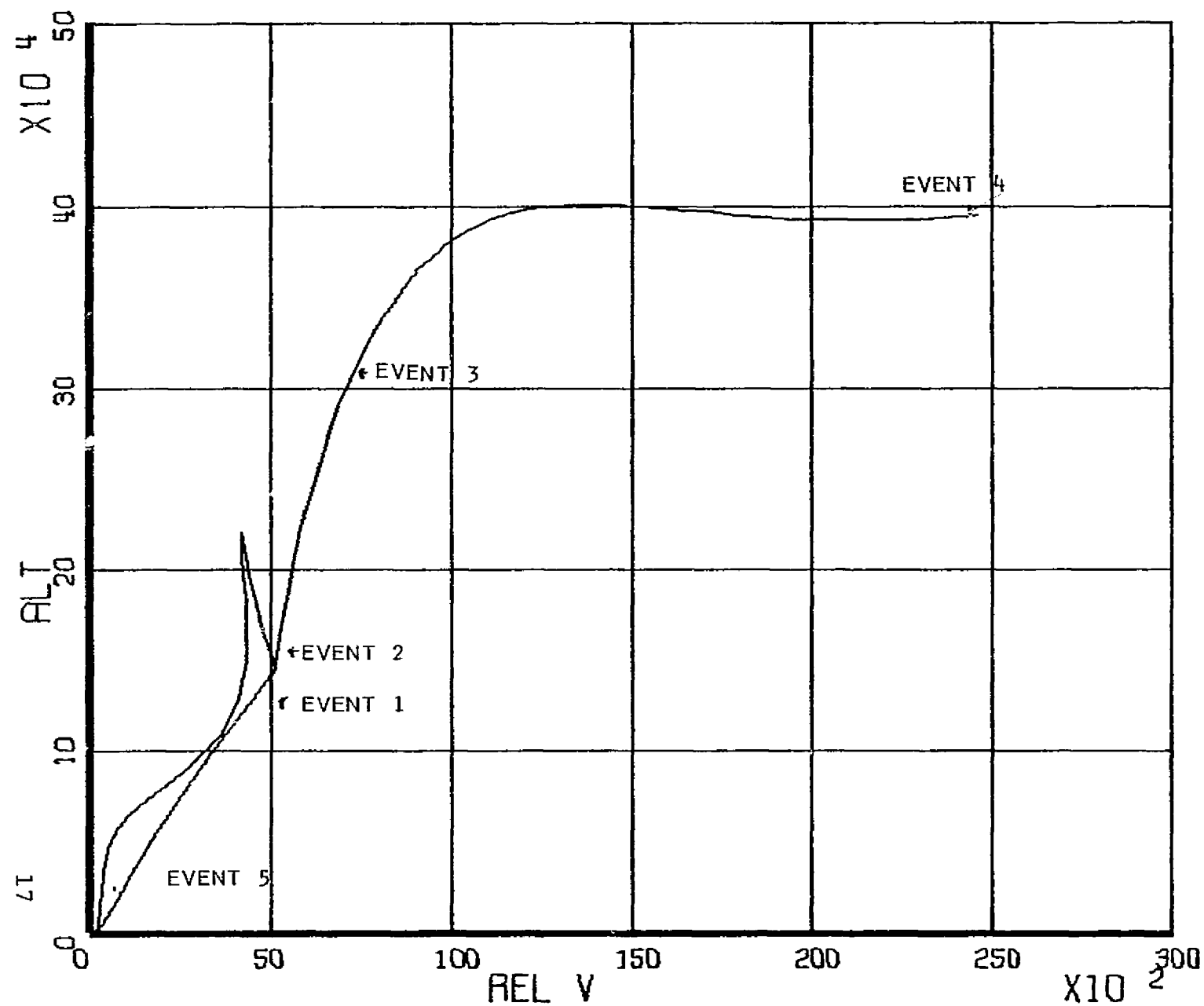
EDIN0501 PROPULSION DATA SEP 75



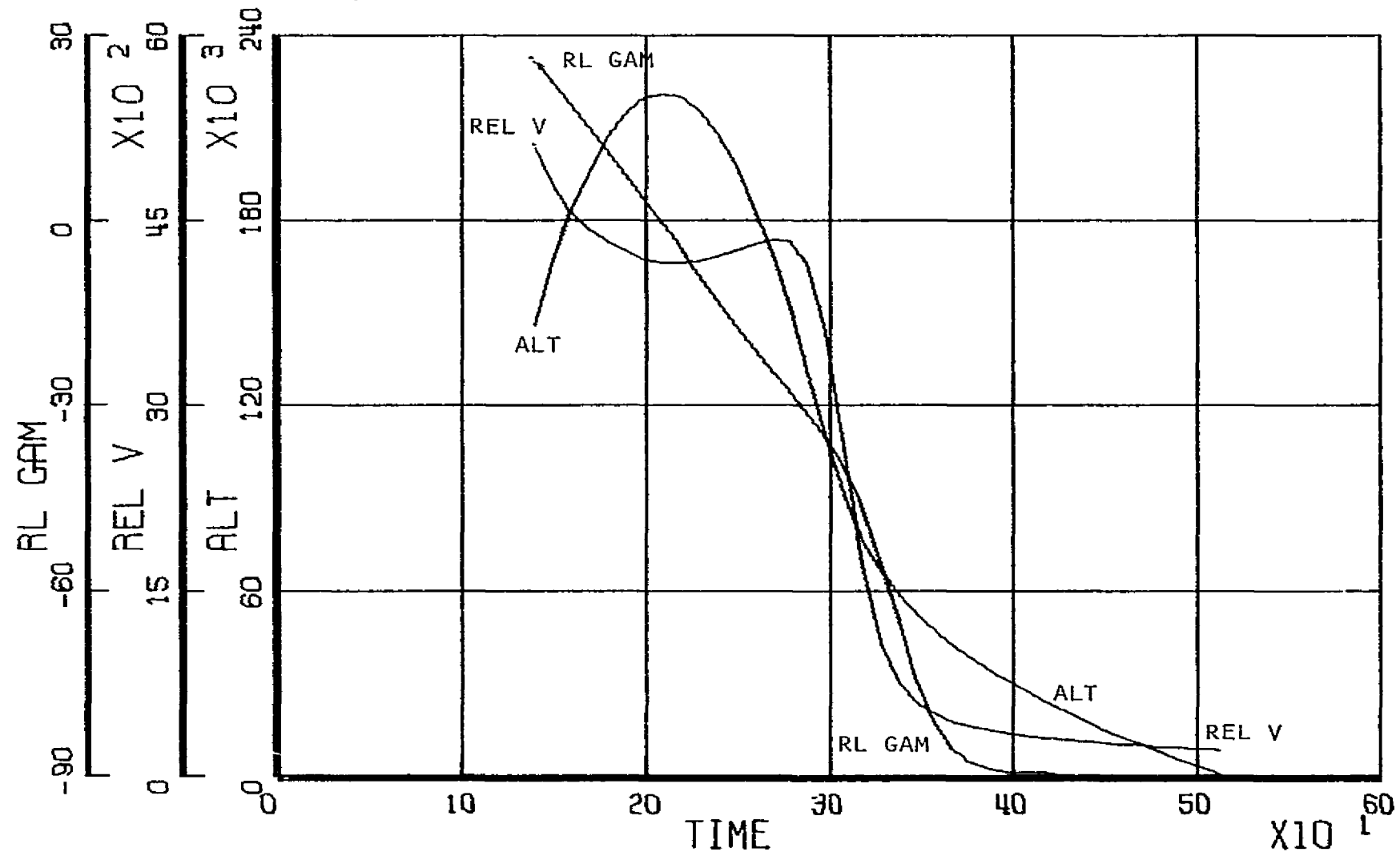
EDIN0501 FLT CONSTRAINTS SEP 75



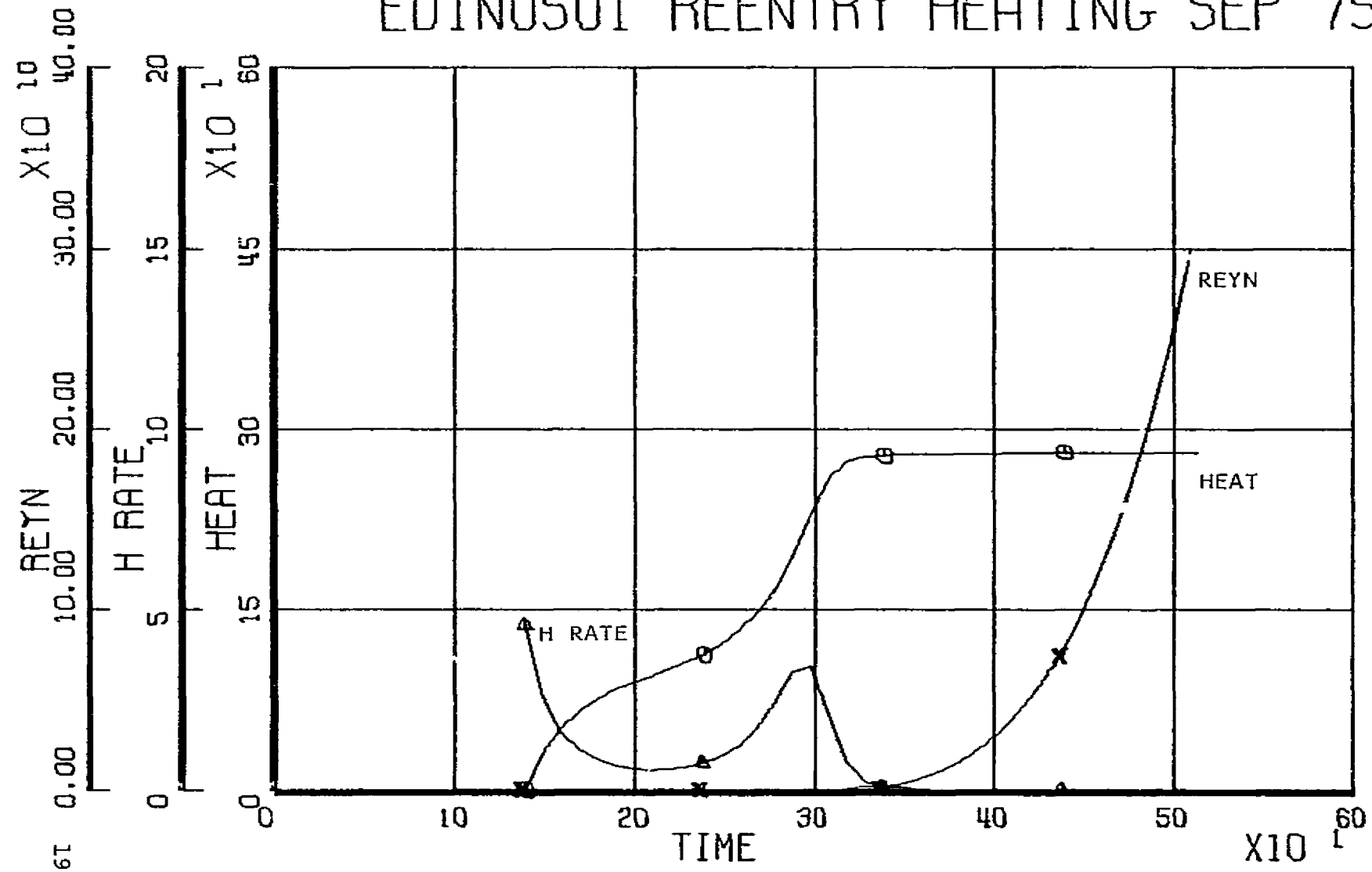
EDIN0501 H-V PROFILE 24 SEP 75



EDIN0501 LRB REENTRY STATE SEP 75



EDIN0501 REENTRY HEATING SEP 75



 MASS PROPERTIES SUMMARY

DATE:22 SEP 75

FORECASTER: EDIN DESIGN CENTER

AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC

STUDY NO: EDIN0501

ORBITER MASS PROPERTIES SUMMARY

	WEIGHT	X-CG	Y-CG	Z-CG
ORBITER EMPTY	151715.00	1135.90	.6	380.70
ORBITER INERT	187254.00	1135.90	.6	380.70
ORBITER LAUNCH	287254.00	1135.90	.6	380.70
	(LB)	(IN)	(IN)	(IN)

EXTERNAL TANK MASS PROPERTIES SUMMARY

	WEIGHT	X-CG	Y-CG	Z-CG
ET EMPTY	87235.55	674.76	0	79.77
ET INERT	98039.20	639.65	0	77.98
ET LAUNCH	1805487.11	160.14	0	64.29
	(LB)	(IN)	(IN)	(IN)

LIQUID ROCKET BOOSTER MASS PROPERTIES SUMMARY

	WEIGHT	X-CG	Y-CG	Z-CG
LRB EMPTY	209125.31	2002.42	0	102.30
LRB INERT	254013.13	1983.08	0	95.44
LRB LAUNCH	2759775.00	1786.27	0	66.44
	(LB)	(IN)	(IN)	(IN)

MISSION MASS PROPERTIES SUMMARY

	WEIGHT	X-CG	Y-CG	Z-CG
LAUNCH	4852516.0	1142.7	.04	84.24
PRE-BECO	1875507.1	650.77	.09	117.2
POST-BECO	1621494.0	442.06	.11	120.6
MECO	385293.20	1009.6	.45	303.7
	(LB)	(IN)	(IN)	(IN)

ET COMPONENTS MASS PROPERTIES

LOXTNK

WT = 16259.52	YCG = .0000000	ZCG = 63.50000
XCG = 14.26938	IYY = 96707.89	IZZ = 96707.89
IKX = 55370.25	IXZ = .0000000	IYZ = .0000000
IKY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

ORIGINAL PAGE IS
OF POOR QUALITY

SUBT 1

WT = 16259.52	YCG = .0000000	ZCG = 63.50000
XCG = 14.26938	IYY = 96707.89	IZZ = 96707.89
IKX = 55370.25	IXZ = .0000000	IYZ = .0000000
IKY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

INRTNK

WT = 12707.69	YCG = .0000000	ZCG = 63.50000
XCG = 241.4819	IYY = 48128.65	IZZ = 48128.65
IKX = 66622.65	IXZ = .0000000	IYZ = .0000000
IKY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 2

WT = 28967.21	YCG = .0000000	ZCG = 63.50000
XCG = 113.9457	IYY = 224317.8	IZZ = 224317.8
IKX = 121992.9	IXZ = -.4316805-03	IYZ = .0000000
IKY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

LH2TNK

WT = 39887.89	YCG = .0000000	ZCG = 63.50000
XCG = 998.8568	IYY = 980678.4	IZZ = 980679.3
IKX = 186692.3	IXZ = .6906888-02	IYZ = .0000000
IKY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 3

WT = 68855.10	YCG = .0000000	ZCG = 63.50000
XCG = 626.5763	IYY = 4041238.	IZZ = 4041239.
IKX = 311685.2	IXZ = .6906888-02	IYZ = .0000000
IKY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

THMPRT

WT = 7728.909	YCG = .0000000	ZCG = 63.50000
XCG = 581.7517	IYY = .0000000	IZZ = .0000000
IKX = .1079201-03	IXZ = .0000000	IYZ = .0000000
IKY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 4

WT = 76584.01	YCG = .0000000	ZCG = 63.50000
XCG = 622.0526	IYY = 4044252.	IZZ = 4044253.
IKX = 311685.2	IXZ = .0000000	IYZ = .0000000
IKY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

PAMSYS

WT = 4503.560	YCG = .0000000	ZCG = 203.5000
XCG = 761.7655	IYY = .0000000	IZZ = -.1381378-01
IXX = .0000000	IXZ = .1726722-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 5

WT = 81087.57	YCG = .0000000	ZCG = 71.27552
XCG = 629.8122	IYY = 4080166.	IZZ = 4062173.
IXX = 329679.3	IXZ = 17957.14	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

ELCSYS

WT = 278.4903	YCG = .0000000	ZCG = 203.5000
XCG = 964.8298	IYY = .0000000	IZZ = .0000000
IXX = .0000000	IXZ = -.1079201-03	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 6

WT = 81366.06	YCG = .0000000	ZCG = 71.72809
XCG = 630.9588	IYY = 4087937.	IZZ = 4068896.
IXX = 330726.6	IXZ = 20610.71	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

ORBATT

WT = 5357.566	YCG = .0000000	ZCG = 203.5000
XCG = 1341.322	IYY = .5525511-01	IZZ = .0000000
IXX = -.8633610-03	IXZ = -.3453444-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 7

WT = 86723.62	YCG = .0000000	ZCG = 73.86862
XCG = 674.8433	IYY = 4654253.	IZZ = 4616374.
IXX = 349565.3	IXZ = 122167.5	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

MNFVAR

WT = 511.9267	YCG = .0000000	ZCG = 63.50000
XCG = 660.7822	IYY = .0000000	IZZ = .0000000
IXX = .0000000	IXZ = -.1079201-03	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

EMPTY 8

WT = 87235.55	YCG = .0000000	ZCG = 79.77257
XCG = 674.7608	IYY = 4654304.	IZZ = 4616396.
IXX = 349594.7	IXZ = 122192.8	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

ORIGINAL PAGE IS
OF POOR QUALITY

RESL0X

WT = 3280.148
XCG = 55.43106
IMX = .0000000
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = .0000000
IXZ = .2698003-04
VOL = .0000000

ZCG = 63.50000
IZZ = -.5396006-04
IYZ = .0000000
AFR = .0000000

SUBT 9

WT = 90615.70
XCG = 651.6585
IMX = 349780.7
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = 4923893.
IXZ = 129271.2
VOL = .0000000

ZCG = 79.16557
IZZ = 4885799.
IYZ = .0000000
AFR = .0000000

RESLH2

WT = 1511.464
XCG = 987.8803
IMX = .0000000
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = .0000000
IXZ = .2158403-03
VOL = .0000000

ZCG = 63.50000
IZZ = .0000000
IYZ = .0000000
AFR = .0000000

SUBT10

WT = 92127.16
XCG = 657.1747
IMX = 349859.4
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = 4960246.
IXZ = 127581.1
VOL = .0000000

ZCG = 78.90855
IZZ = 4922073.
IYZ = .0000000
AFR = .0000000

FLTPFR

WT = 5912.040
XCG = 366.6134
IMX = .0000000
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = .0000000
IXZ = .4316805-03
VOL = .0000000

ZCG = 63.50000
IZZ = .0000000
IYZ = .0000000
AFR = .0000000

ENRT11

WT = 98039.20
XCG = 639.6530
IMX = 350144.1
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = 5061767.
IXZ = 132949.7
VOL = .0000000

ZCG = 77.97937
IZZ = 5023308.
IYZ = .0000000
AFR = .0000000

LDMFUL

WT = 1463527.
XCG = 12.96441
IMX = .2762755-01
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = .2762755-01
IXZ = -.6906888-02
VOL = .0000000

ZCG = 63.50000
IZZ = .0000000
IYZ = .0000000
AFR = .0000000

SUBT12

WT = 1561566.
XCG = 52.30956
IMX = 354302.0
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = .1285482+08
IXZ = 312908.9
VOL = .0000000

ZCG = 64.40905
IZZ = .1281221+08
IYZ = .0000000
AFR = .0000000

LH2FUL

WT = 243921.1	YCG = .0000000	ZCG = 63.50000
XCG = 850.4968	IYY = .0000000	IZZ = .0000000
IXX = .0000000	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	APR = .0000000
ASF = .0000000		

ETFL13

WT = 1805487.	YCG = .0000000	ZCG = 64.28624
XCG = 160.1446	IYY = .4186551+08	IZZ = .4182296+08
IXX = 354339.6	IXZ = 279868.7	IYZ = .0000000
IXY = .0000000	VOL = .0000000	APR = .0000000
ASF = .0000000		

LQX

WT = 403926.1	YCG = .0000000	ZCG = 63.50000
XCG = -325.0305	IYY = -.2210204	IZZ = .0000000
IXX = .0000000	IXZ = -.2762755-01	IYZ = .0000000
IXY = .0000000	VOL = .0000000	APR = .0000000
ASF = .0000000		

SUBT14

WT = 1401561.	YCG = .0000000	ZCG = 64.51283
XCG = 299.9707	IYY = .1542835+08	IZZ = .1538577+08
IXX = 354270.2	IXZ = 237026.7	IYZ = .0000000
IXY = .0000000	VOL = .0000000	APR = .0000000
ASF = .0000000		

LH2

WT = 67321.02	YCG = .0000000	ZCG = 63.50000
XCG = 444.5338	IYY = .0000000	IZZ = .0000000
IXX = .1726722-02	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	APR = .0000000
ASF = .0000000		

ETBC15

WT = 1334240.	YCG = .0000000	ZCG = 64.56394
XCG = 292.6766	IYY = .1510934+08	IZZ = .1506678+08
IXX = 354254.5	IXZ = 239261.6	IYZ = .0000000
IXY = .0000000	VOL = .0000000	APR = .0000000
ASF = .0000000		

LRB COMPONENTS MASS PROPERTIES

LOXTNK

WT = 20678.60	YCG = .0000000	ZCG = 63.50000
XCG = 1658.737	IYY = 69679.56	IZZ = 69679.56
IXX = 110566.4	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 1

WT = 20678.60	YCG = .0000000	ZCG = 63.50000
XCG = 1658.737	IYY = 69679.56	IZZ = 69679.56
IXX = 110566.4	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

RPTANK

WT = 14021.99	YCG = .0000000	ZCG = 63.50000
XCG = 2010.528	IYY = 45538.83	IZZ = 45538.83
IXX = 75212.80	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 2

WT = 34700.59	YCG = .0000000	ZCG = 63.50000
XCG = 1800.890	IYY = 338419.4	IZZ = 338419.4
IXX = 185779.2	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

INTSTG

WT = 8583.270	YCG = .0000000	ZCG = 63.50000
XCG = 1448.402	IYY = 60118.55	IZZ = 60118.55
IXX = 90145.90	IXZ = -.1726722-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 3

WT = 43293.86	YCG = .0000000	ZCG = 63.50000
XCG = 1730.991	IYY = 583076.2	IZZ = 583075.7
IXX = 275925.1	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

AFTSKT

WT = 16159.43	YCG = .0000000	ZCG = 63.50000
XCG = 2157.099	IYY = 285024.4	IZZ = 285024.4
IXX = 144423.6	IXZ = -.6906888-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 4

WT = 59443.29	YCG = .0000000	ZCG = 63.50000
XCG = 1846.827	IYY = 1329226.	IZZ = 1329226.
IXX = 420348.7	IXZ = -.2762755-01	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

THRSTR

WT = 33615.19		
XCG = 2100.257	YCG = .0000000	ZCG = 63.50000
INX = 142223.4	IYY = 71894.41	IZZ = 71895.29
IXY = .0000000	IXZ = .1381373-01	IYZ = .0000000
ASF = .0000000	VOL = .0000000	AFR = .0000000

SUBT 5

WT = 93058.48		
XCG = 1938.373	YCG = .0000000	ZCG = 63.50000
INX = 562572.1	IYY = 1698788.	IZZ = 1698788.
IXY = .0000000	IXZ = -.5525511-01	IYZ = .0000000
ASF = .0000000	VOL = .0000000	AFR = .0000000

STBLZR

WT = 6916.000		
XCG = 1475.266	YCG = .0000000	ZCG = 63.50000
INX = .0000000	IYY = .0000000	IZZ = .0000000
IXY = .0000000	IXZ = .0000000	IYZ = .0000000
ASF = .0000000	VOL = .0000000	AFR = .0000000

SUBT 6

WT = 99974.48		
XCG = 1906.336	YCG = .0000000	ZCG = 63.50000
INX = 562572.1	IYY = 1996789.	IZZ = 1996790.
IXY = .0000000	IXZ = .0000000	IYZ = .0000000
ASF = .0000000	VOL = .0000000	AFR = .0000000

TNKINS

WT = 940.8276		
XCG = 1875.934	YCG = .0000000	ZCG = 63.50000
INX = .0000000	IYY = -.1381373-01	IZZ = -.1381373-01
IXY = .0000000	IXZ = -.2158403-03	IYZ = .0000000
ASF = .0000000	VOL = .0000000	AFR = .0000000

SUBT 7

WT = 100915.3		
XCG = 1906.053	YCG = .0000000	ZCG = 63.50000
INX = 562572.1	IYY = 1996976.	IZZ = 1996976.
IXY = .0000000	IXZ = .0000000	IYZ = .0000000
ASF = .0000000	VOL = .0000000	AFR = .0000000

ABLMTL

WT = 1248.377		
XCG = 1807.739	YCG = .0000000	ZCG = 261.5000
INX = .0000000	IYY = -.1381373-01	IZZ = -.1381373-01
IXY = .0000000	IXZ = .0000000	IYZ = .0000000
ASF = .0000000	VOL = .0000000	AFR = .0000000

SUBT 8

WT = 102163.7		
XCG = 1904.851	YCG = .0000000	ZCG = 65.91944
INX = 573006.5	IYY = 2009993.	IZZ = 1999547.
IXY = .0000000	IXZ = -5181.023	IYZ = .0000000
ASF = .0000000	VOL = .0000000	AFR = .0000000

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ELECSY

WT = 684.4820
XCG = 1807.739
IXX = .0000000
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = .0000000
IXZ = -.2158403-03
VDL = .0000000

ZCG = 63.50000
IZZ = -.1381378-01
IYZ = .0000000
AFR = .0000000

SUBT 9

WT = 102848.2
XCG = 1904.205
IXX = 573007.4
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = 2011367.
IXZ = -5146.571
VDL = .0000000

ZCG = 65.90333
IZZ = 2000931.
IYZ = .0000000
AFR = .0000000

CONTSY

WT = 114.9930
XCG = 1421.539
IXX = .0000000
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = -.8633610-03
IXZ = .2698003-04
VDL = .0000000

ZCG = 63.50000
IZZ = -.8633610-03
IYZ = .0000000
AFR = .0000000

SUBT10

WT = 102963.2
XCG = 1903.666
IXX = 573007.5
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = 2017144.
IXZ = -5117.811
VDL = .0000000

ZCG = 65.90065
IZZ = 2006708.
IYZ = .0000000
AFR = .0000000

INSTSY

WT = 1520.000
XCG = 1421.539
IXX = .0000000
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = .1381378-01
IXZ = .0000000
VDL = .0000000

ZCG = 63.50000
IZZ = .0000000
IYZ = .0000000
AFR = .0000000

SUBT11

WT = 104483.2
XCG = 1896.652
IXX = 573009.4
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = 2092296.
IXZ = -4743.651
VDL = .0000000

ZCG = 65.86573
IZZ = 2081857.
IYZ = .0000000
AFR = .0000000

ENGNES

WT = 57114.00
XCG = 2214.257
IXX = 31949.99
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = 21301.06
IXZ = -.5525511-01
VDL = .0000000

ZCG = 162.5000
IZZ = 21299.30
IYZ = .0000000
AFR = .0000000

SUBT12

WT = 161597.2
XCG = 2008.905
IXX = 679389.7
IXY = .0000000
ASF = .0000000

YCG = .0000000
IYY = 2992037.
IXZ = 239884.3
VDL = .0000000

ZCG = 100.0196
IZZ = 2907168.
IYZ = .0000000
AFR = .0000000

ACCESS

WT = 416.4000	YCG = .0000000	ZCG = 162.5000
XCG = 2214.257	IYY = -.6906888-02	IZZ = -.6906888-02
IXX = .0000000	IXZ = .4316805-03	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT13

WT = 162013.6	YCG = .0000000	ZCG = 100.1802
XCG = 2009.432	IYY = 2996167.	IZZ = 2910945.
IXX = 679739.7	IXZ = 241034.5	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

GMBLSY

WT = 5283.000	YCG = .0000000	ZCG = 162.5000
XCG = 2100.257	IYY = .0000000	IZZ = -.1105102
IXX = .0000000	IXZ = -.3453444-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT14

WT = 167296.6	YCG = .0000000	ZCG = 102.1482
XCG = 2012.301	IYY = 3009566.	IZZ = 2920058.
IXX = 684028.4	IXZ = 247284.9	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

BHTSHD

WT = 4356.000	YCG = .0000000	ZCG = 63.50000
XCG = 1985.940	IYY = .0000000	IZZ = .0000000
IXX = .0000000	IXZ = -.3453444-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT15

WT = 171652.6	YCG = .0000000	ZCG = 101.1674
XCG = 2011.632	IYY = 3011571.	IZZ = 2920695.
IXX = 685397.1	IXZ = 248218.5	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

FUELSY

WT = 8388.600	YCG = .0000000	ZCG = 142.7000
XCG = 2100.257	IYY = .0000000	IZZ = .0000000
IXX = .0000000	IXZ = .6906888-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT16

WT = 180041.2	YCG = .0000000	ZCG = 103.1025
XCG = 2015.761	IYY = 3028107.	IZZ = 2934253.
IXX = 688374.8	IXZ = 254572.4	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

OXIDSY

WT = 12419.02	YCG = .0000000	ZCG = 142.7000
XCG = 2032.960	IYY = .2210204	IZZ = .0000000
IXX = -.8633610-03	IXZ = -.6906888-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT17

WT = 192460.2	YCG = .0000000	ZCG = 105.6576
XCG = 2016.871	IYY = 3032782.	IZZ = 2934996.
IXX = 692306.5	IXZ = 256280.4	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SEPSYS

WT = 2488.139	YCG = .0000000	ZCG = 63.50000
XCG = 1349.380	IYY = .0000000	IZZ = .0000000
IXX = -.5396006-04	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT18

WT = 194948.3	YCG = .0000000	ZCG = 105.1196
XCG = 2008.351	IYY = 3269942.	IZZ = 3171215.
IXX = 693248.8	IXZ = 271199.7	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

CHUTSY

WT = 5724.150	YCG = .0000000	ZCG = 63.50000
XCG = 1441.540	IYY = .0000000	IZZ = -.5525511-01
IXX = .0000000	IXZ = .1726722-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT19

WT = 200672.5	YCG = .0000000	ZCG = 103.9324
XCG = 1992.183	IYY = 3657637.	IZZ = 3556830.
IXX = 695327.9	IXZ = 299514.5	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

FLOTSY

WT = 103.5436	YCG = .0000000	ZCG = 63.50000
XCG = 1441.540	IYY = .8633610-03	IZZ = .8633610-03
IXX = -.1686252-05	IXZ = .2698003-04	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT20

WT = 200776.0	YCG = .0000000	ZCG = 103.9115
XCG = 1991.899	IYY = 3664448.	IZZ = 3563606.
IXX = 695364.4	IXZ = 300011.7	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

RECRDS

WT = 102.2156	YCG = .0000000	ZCG = 63.50000
XCG = 1411.540	IYY = .0000000	IZZ = .0000000
IXX = .0000000	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT21

WT = 200878.2	YCG = .0000000	ZCG = 103.8910
XCG = 1991.604	IYY = 3671910.	IZZ = 3571029.
IXX = 695400.4	IXZ = 300528.9	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

FITSUP

WT = 197.0792	YCG = .0000000	ZCG = 63.50000
XCG = 1555.857	IYY = -.1726722-02	IZZ = -.1726722-02
IXX = .0000000	IXZ = -.5396006-04	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT22

WT = 201075.3	YCG = .0000000	ZCG = 103.8514
XCG = 1991.177	IYY = 3680050.	IZZ = 3579099.
IXX = 695469.7	IXZ = 301276.7	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

RETRSY

WT = 3173.528	YCG = .0000000	ZCG = 63.50000
XCG = 2214.257	IYY = -.1105102	IZZ = -.1105102
IXX = .0000000	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT23

WT = 204248.8	YCG = .0000000	ZCG = 103.2244
XCG = 1994.643	IYY = 3714706.	IZZ = 3612658.
IXX = 696567.7	IXZ = 295206.6	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

RHTSHD

WT = 4876.489	YCG = .0000000	ZCG = 63.50000
XCG = 2328.257	IYY = .0000000	IZZ = .0000000
IXX = .0000000	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

EPTY24

WT = 209125.3	YCG = .0000000	ZCG = 102.2981
XCG = 2002.422	IYY = 3830747.	IZZ = 3727073.
IXX = 698189.9	IXZ = 281582.9	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

FLBIAS

WT = 1800.000	YCG = .0000000	ZCG = 63.50000
XCG = 2010.528	IYY = .0000000	IZZ = .0000000
IMX = .0000000	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT25

WT = 210925.3	YCG = .0000000	ZCG = 101.9670
XCG = 2002.492	IYY = 3831348.	IZZ = 3727097.
IMX = 698769.7	IXZ = 281461.8	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

LOWGAS

WT = 3870.703	YCG = .0000000	ZCG = 63.50000
XCG = 1653.737	IYY = -.5525511-01	IZZ = -.5525511-01
IMX = .0000000	IXZ = .8633610-03	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT26

WT = 214796.0	YCG = .0000000	ZCG = 101.2738
XCG = 1996.297	IYY = 3929510.	IZZ = 3824046.
IMX = 699983.7	IXZ = 292309.9	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

RPGAS

WT = 3439.784	YCG = .0000000	ZCG = 63.50000
XCG = 2010.528	IYY = .0000000	IZZ = .0000000
IMX = .0000000	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT27

WT = 218235.8	YCG = .0000000	ZCG = 100.6784
XCG = 1996.521	IYY = 3930698.	IZZ = 3824191.
IMX = 701026.3	IXZ = 291917.1	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

FROST

WT = 433.5114	YCG = .0000000	ZCG = 63.50000
XCG = 1807.739	IYY = .0000000	IZZ = -.6906888-02
IMX = .6745008-05	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT28

WT = 218669.3	YCG = .0000000	ZCG = 100.6047
XCG = 1996.147	IYY = 3934156.	IZZ = 3827522.
IMX = 701155.4	IXZ = 292572.7	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

TRAPRP

WT = 12957.93	YCG = .0000000	ZCG = 63.50000
XCG = 2043.099	IYY = .0000000	IZZ = .0000000
IXX = .0000000	IXZ = .0000000	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT29

WT = 231627.2	YCG = .0000000	ZCG = 98.52899
XCG = 1998.774	IYY = 3943609.	IZZ = 3833339.
IXX = 704790.6	IXZ = 287972.9	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

TRPLOX

WT = 18073.13	YCG = .0000000	ZCG = 63.50000
XCG = 1818.776	IYY = .0000000	IZZ = .0000000
IXX = .4316805-03	IXZ = .3453444-02	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT30

WT = 249700.4	YCG = .0000000	ZCG = 95.99361
XCG = 1985.745	IYY = 4065287.	IZZ = 3950579.
IXX = 709230.7	IXZ = 310788.5	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

RPLOSS

WT = 2084.150	YCG = .0000000	ZCG = 63.50000
XCG = 2010.528	IYY = .0000000	IZZ = .2762755-01
IXX = .5396006-04	IXZ = -.4316805-03	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT31

WT = 251784.5	YCG = .0000000	ZCG = 95.72465
XCG = 1985.951	IYY = 4066033.	IZZ = 3950851.
IXX = 709701.7	IXZ = 310423.3	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

LDXLOS

WT = 2228.614	YCG = .0000000	ZCG = 63.50000
XCG = 1658.737	IYY = .0000000	IZZ = .0000000
IXX = .5396006-04	IXZ = .4316805-03	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

INRT32

WT = 254013.1	YCG = .0000000	ZCG = 95.44192
XCG = 1983.080	IYY = 4117582.	IZZ = 4001905.
IXX = 710196.8	IXZ = 315456.7	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

RP			
WT	=	766288.1	
XCG	=	2010.528	YCG = .0000000
IXX	=	.0000000	IZZ = -14.14531
IXY	=	.0000000	IYZ = .0000000
ASF	=	.0000000	AFR = .0000000
SUBT33			
WT	=	1020301.	
XCG	=	2003.694	YCG = .0000000
IXX	=	752208.9	IZZ = 4032912.
IXY	=	.0000000	IYZ = .0000000
ASF	=	.0000000	AFR = .0000000
LQX			
WT	=	1739474.	
XCG	=	1658.737	YCG = .0000000
IXX	=	-.2762755-01	IZZ = .0000000
IXY	=	.0000000	IYZ = .0000000
ASF	=	.0000000	AFR = .0000000
BLOW34			
WT	=	2759775.	
XCG	=	1786.269	YCG = .0000000
IXX	=	760986.6	IZZ = .2055008+08
IXY	=	.0000000	IYZ = .0000000
ASF	=	.0000000	AFR = .0000000

MISSION MASS PROPERTIES - LIFTOFF

PROPERTY QUALITY

OB-L/O

WT = 287254.0	YCG = .6000000	ZCG = 380.7000
XCG = 1135.900	IYY = 6261866.	IZZ = 6497481.
IXX = 849089.5	IXZ = 257323.7	IYZ = -2174.700
IXY = -6587.000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 1

WT = 287254.0	YCG = .6000000	ZCG = 380.7000
XCG = 1135.900	IYY = 6261866.	IZZ = 6497481.
IXX = 849089.5	IXZ = 257323.7	IYZ = -2174.700
IXY = -6587.000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

ET-L/O

WT = 1805487.	YCG = .0000000	ZCG = 64.28624
XCG = 160.1446	IYY = .4186551+08	IZZ = .4182286+08
IXX = 354339.6	IXZ = 279863.6	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 2

WT = 2092741.	YCG = .8235725-01	ZCG = 107.7178
XCG = 294.0788	IYY = .1044110+09	IZZ = .9924868+08
IXX = 6558802.	IXZ = .1705201+08	IYZ = 7980.396
IXY = 24729.24	VOL = .0000000	AFR = .0000000
ASF = .0000000		

LB-L/O

WT = 2759775.	YCG = .0000000	ZCG = 66.43997
XCG = 1786.269	IYY = .2071648+08	IZZ = .2055002+08
IXX = 760986.6	IXZ = 660119.0	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

LNCH 3

WT = 4852516.	YCG = .3551815-01	ZCG = 84.24185
XCG = 1142.733	IYY = .6975747+09	IZZ = .6918082+09
IXX = 7757503.	IXZ = 1888855.	IYZ = 8853.716
IXY = -6841.208	VOL = .0000000	AFR = .0000000
ASF = .0000000		

MISSION MASS PROPERTIES - PRIOR-BECO

DB-PSP

WT = 287254.0	YCG = .6000000	ZCG = 380.7000
XCG = 1135.900	IYY = 6261806.	IZZ = 6497481.
IXX = 849089.5	IXZ = 257323.7	IYZ = -2174.700
IXY = -6587.000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 1

WT = 287254.0	YCG = .6000000	ZCG = 380.7000
XCG = 1135.900	IYY = 6261866.	IZZ = 6497481.
IXX = 849089.5	IXZ = 257323.7	IYZ = -2174.700
IXY = -6587.000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

ET-PSP

WT = 1334240.	YCG = .0000000	ZCG = 64.56393
XCG = 292.6766	IYY = .1510934+08	IZZ = .1506678+08
IXX = 354254.5	IXZ = 239261.5	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 2

WT = 1621494.	YCG = .1062923	ZCG = 120.5687
XCG = 442.0569	IYY = .6274456+08	IZZ = .5783886+08
IXX = 6302130.	IXZ = .1409643+08	IYZ = 7502.338
IXY = 19224.37	VOL = .0000000	AFR = .0000000
ASF = .0000000		

LB-PSP

WT = 254013.1	YCG = .0000000	ZCG = 95.44192
XCG = 1983.080	IYY = 4117582.	IZZ = 4001902.
IXX = 710196.8	IXZ = 315456.6	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

PRSP 3

WT = 1875507.	YCG = .9189642-01	ZCG = 117.1656
XCG = 650.7685	IYY = .1794571+09	IZZ = .1744058+09
IXX = 7042254.	IXZ = .1257648+08	IYZ = 7628.935
IXY = 11460.18	VOL = .0000000	AFR = .0000000
ASF = .0000000		

MISSION MASS PROPERTIES - POST-BECO

OB-ASP

WT = 287254.0	YCG = .60000000	ZCG = 380.7000
XCG = 1135.900	IYY = 6261866.	IZZ = 6497481.
IXX = 849089.5	IXZ = 257323.7	IYZ = -2174.700
IXY = -6587.000	VOL = .00000000	AFR = .00000000
ASF = .00000000		

SUBT 1

WT = 287254.0	YCG = .60000000	ZCG = 380.7000
XCG = 1135.900	IYY = 6261866.	IZZ = 6497481.
IXX = 849089.5	IXZ = 257323.7	IYZ = -2174.700
IXY = -6587.000	VOL = .00000000	AFR = .00000000
ASF = .00000000		

ET-ASP

WT = 1334240.	YCG = .00000000	ZCG = 64.56393
XCG = 292.6766	IYY = .1510934+08	IZZ = .1506678+08
IXX = 354254.5	IXZ = 239261.5	IYZ = .00000000
IXY = .00000000	VOL = .00000000	AFR = .00000000
ASF = .00000000		

AFSP 2

WT = 1621494.	YCG = .1062923	ZCG = 120.5687
XCG = 442.0569	IYY = .6274456+08	IZZ = .5783886+08
IXX = 6302130.	IXZ = .1409643+08	IYZ = 7502.338
IXY = 19224.37	VOL = .00000000	AFR = .00000000
ASF = .00000000		

MISSION MASS PROPERTIES - MECO

OB-MCO

WT = 287254.0	YCG = .6000000	ZCG = 380.7000
XCG = 1135.900	IYY = 6261866.	IZZ = 6497481.
IXX = 849089.5	IXZ = 257323.7	IYZ = -2174.700
IXY = -6587.000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SUBT 1

WT = 287254.0	YCG = .6000000	ZCG = 380.7000
XCG = 1135.900	IYY = 6261866.	IZZ = 6497481.
IXX = 849089.5	IXZ = 257323.7	IYZ = -2174.700
IXY = -6587.000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

ET-MCO

WT = 98039.20	YCG = .0000000	ZCG = 77.97937
XCG = 639.6530	IYY = 5061767.	IZZ = 5023308.
IXX = 350144.1	IXZ = 132949.7	IYZ = .0000000
IXY = .0000000	VOL = .0000000	AFR = .0000000
ASF = .0000000		

MECO 2

WT = 385293.2	YCG = .4473279	ZCG = 303.6717
XCG = 1009.628	IYY = .1665448+08	IZZ = .1540590+08
IXX = 2644982.	IXZ = 2760265.	IYZ = 690.7987
IXY = -1889.615	VOL = .0000000	AFR = .0000000
ASF = .0000000		

SIGMA CORPORATION

EDIN0502A DESIGN
SIMULATION RESULTS

FORECASTER: EDIN DESIGN CENTER DATE: 10 OCT 75
AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC TIME: 17:07
STUDY NO: EDIN0502

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 7.00 HIGH
PRESSURE ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR
REPLACEMENT OF THE SOLID ROCKET BOOSTERS.

MISSION: MAXIMUM PAYLOAD
DUE EAST LAUNCH FROM ETR
A 250 FPS OMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL
MILE REFERENCE ORBIT.
A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED EXO-ATMOSPHERIC PITCH
PROFILE AND INITIAL TILT RATE.
MID POINT CONSTRAINT = SHUTTLE MISSION 1 RTLS/ADR
END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
ATMOSPHERIC INFLIGHT CONSTRAINTS CONTROLLED BY HIGH
PRESSURE ENGINE THROTTLING AND/OR SOME THROTTLING.
MAX DYNAMIC PRESSURE = 650.0 PSF
MAX ACCELERATION = 3.0 G

PROPULSION: LRB: 7.00 HIGH PPESSURE ENGINES RATED AS FOLLOWS:
THRUST(SL) = 680000.00 LBS
THRUST(VAC) = 735300.00 LBS
THROTTLE = 1.00 TO .500
ISP(SL) = 319.60 SEC.
ISP(VAC) = 345.60 SEC.
FLOWRATE = 2127.7 LB/SEC
EXIT AREA = 27.122 SQ FT
MIX RATIO = 2.40:1
ORBITER: THREE SOME ENGINES RATED AS FOLLOWS:
THRUST(SL) = 375000.00 LBS
THRUST(VAC) = 470000.00 LBS
THROTTLE = 1.00 TO .500
ISP(SL) = 363.20 SEC
ISP(VAC) = 455.20 SEC
FLOWRATE = 1032.5 LB/SEC
EXIT AREA = 44.896 SQ FT
MIX RATIO = 6.00:1

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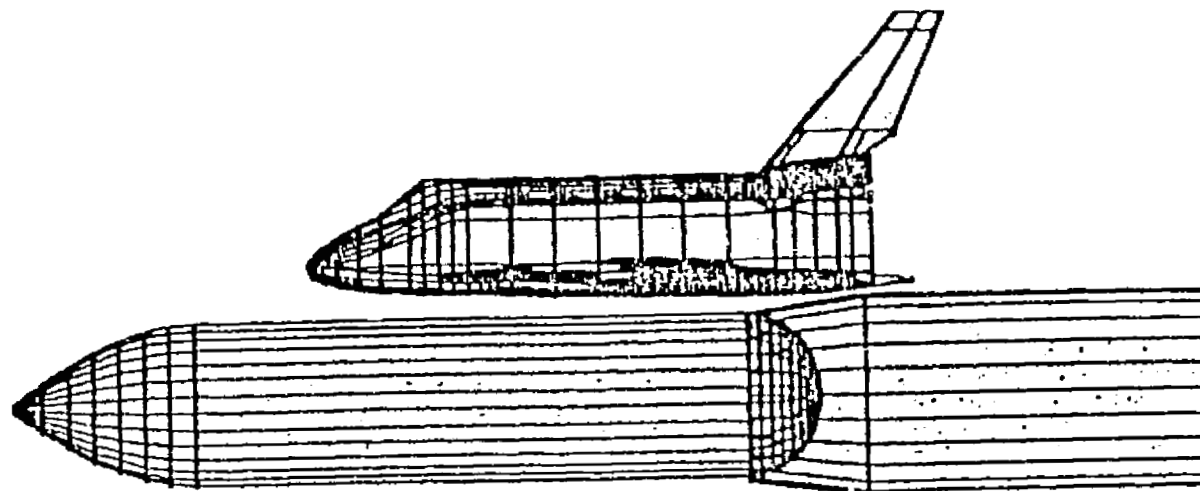
AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION
WERE OBTAINED FROM SHUTTLE AERO ESTIMATES. ADJUSTMENTS
WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
REF AREA = 2557.0 SQ FT

STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS
ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND
INCREASED UP PAYLOADS.

MASS
PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC
ASSUMPTIONS.
LRB: WERS BASED ON SATURN TECHNOLOGY.
ET: FIXED MASS FRACTION DISTRIBUTED IN
ACCORDANCE WITH SHUTTLE ET WEIGHT
STATEMENT.
ORBITER: FEB 1975 SHUTTLE WITH MODS FOR
INCREASED UP PAYLOAD.

EDIN0502A DESIGN SIMULATION RESULTS.

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WEIGHTS SUMMARY REPORT

GLOW		4817348.62
ET LIFT-OFF WEIGHT		1805487.20
ET INERT WEIGHT	98039.26	
ET PROPELLANT	1707487.61	
LRB LIFT-OFF WEIGHT		2692607.59
LRB INERT WEIGHT	234010.25	
LRB PROPELLANT	2458597.34	
ORBITER LIFT-OFF WEIGHT		319254.00
ORBITER INERT WEIGHT	187254.00	
PAYLOAD	132000.00	

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	2862.	
BODY GROUP	43291.	
INDUCED ENVIRN PROTECT	19874.	
LANDING & AUX SYSTEMS	7683.	
PROPULSION-ASCENT	28054.	
PROPULSION-RCS	2657.	
PROPULSION-QMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2739.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 100K PAYLD	390.	
ORBITER EMPTY WEIGHT		151715.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	5024.	
PROPELLANT-RCS	6241.	
PROPELLANT-QMS	16149.	
ORBITER INERT WEIGHT		187254.
PAYLOAD		132000.
ORBITER PRELAUNCH WEIGHT		319254.

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EXTERNAL TANK WEIGHT STATEMENT:

LOX TANK		16260.
BHD	79.	
FWD FRAME	51.	
FWD OGIVE	1342.	
AFT OGIVE	4511.	
XT 745 FRAME	313.	
BARREL	2917.	
INTERTANK FRAME	1064.	
AFT DOME	3469.	
SLOSH BAFFLES	2514.	
INTERTANK		12708.
MACHINED BARREL PNLS	5088.	
SK/STGR BARREL PNLS	5500.	
STABILIZING FRAMES(4)	1505.	
SRB THRST XT 985 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	68.	
BARREL PNLS SPLICES (8)	113.	
FRAME STABLIZERS	244.	
ET ASSY FASTENERS	191.	

ART DOME	1908.	
AT 1123.9 FRAME	1877.	
BARREL NO.4	5825.	
AT 1877 FRAME	5825.	
BARREL NO.3	5825.	
AT 1624 FRAME	5825.	
BARREL NO.2	5825.	
AT 1671 FRAME	5825.	
BARREL NO.1	5825.	
AT 1022 FRAME	5825.	
ART DOME	5825.	
THERMAL PROTECTION	5825.	
LOX TANK		7729.
INTERTANK	1437.	
LHE TANK	1730.	
PROP. (MECH+ELEC)	4097.	
PROPULSION AND MECHANICAL SYSTEM:	314.	
LOX FEED SYS		4504.
LOX ANTISIEVE SYS	1288.	
LOX VENT SYS	131.	
LOX PRESS. SYS	101.	
LHE FEED SYS	312.	
LHE RECIP. SYS	551.	
LHE VENT SYS	36.	
LHE PRESS. SYS	153.	
HELIUM INJ. SYS	132.	
INTERTANK PURGE SYS	25.	
ASCARD GAS DETECTION SYS	25.	
PIPING AND CONDUIT	10.	
LINE CUPT. AND ATTACH.	407.	
ELECTRICAL SYSTEM	637.	
ET WIRING ASSY		275.
IRE WIRING ASSY	138.	
INSTRUMENTATION	0.	
CABELING ATTACH. + SENSOR CUPT.	17.	
ORBITER ATTACHMENTS	73.	
ORBITER SUPPORTS		5338.
UMBILICAL BEAM	3277.	
ORBITER ATTACH FTGS	754.	
IREMET ATTACH FTGS	330.	
ET/ORBITER UMBILICAL ADMP	0.	
MANUFACTURING VARIATION MT.	347.	
EMPTY WEIGHT		506.
UNUSABLE FLUIDS		87530.
LHE IN TANK		466.
LHE IN LINE	273.	
LOX IN LINE	56.	
PRE-PRESS. + INFLIGHT GASES	157.	
GHE		2408.
SDX	1145.	
HELIUM	3123.	
SEPARATION HARDWARE	37.	
IRE SUPPORTS		6.
IRE FITTINGS	0.	
ET PERA RES	6.	
ET INERT MT		5942.
MAIN PROPELLANTS		95032.
LOX		1707443.
LHE	1423527.	
ET LIFT-OFF WEIGHT	243321.	
ALL FRACTION		180547.

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LIQUID ROCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		93058.
INTEGRAL LOX TANK	20679.	
INTEGRAL FUEL TANK	14022.	
INTERSTAGE	8583.	
AFT SKIRT	16159.	
THRUST STRUCTURE	33615.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		2189.
TANK INSULATION	941.	
RELATIVE MATERIAL	1248.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		799.
ELECTRICAL SYSTEM	684.	
CONTROL SYSTEM	115.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		68208.
ENGINES (DRY)	37345.	
ACCESSORIES	416.	
GIMBAL SYSTEM	5283.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	8389.	
OXIDIZER SYSTEM	12419.	
SEPARATION AND RECOVERY SYSTEM		16665.
SEPARATION SYSTEM	2488.	
CHUTE SYS (MAIN AND DROGUE)	5724.	
FLOATATION SYSTEM	104.	
RECOVERY AIDS	102.	
FITTINGS AND SUPPORTS	197.	
RETRO SYS (100 F/S DEL V)	3174.	
REENTRY HEAT SHIELD	4876.	
STAGE DRY WEIGHT		189356.
CONTINGENCY		0.
EMPTY WEIGHT		189356.
PROPELLANT RESIDUALS		40383.
FUEL BIAS	1800.	
TRAPPED LOX TANK GASES	3871.	
TRAPPED FUEL TANK GASES	3440.	
FROST TRAPPED	434.	
TRAPPED FUEL	12160.	
TRAPPED LOX	18073.	
IN-FLIGHT LOSSES		4271.
FUEL LOSSES	1956.	
LOX LOSSES	2229.	
MAIN PROPELLANTS		2458598.
FUEL	719124.	
LOX	1739474.	
BLOW		2692608.
MASS FRACTION (BASED ON INERT WT)		.9131

ORBITER WT	319254.0
ET WEIGHT	1805487.2
LRB STAGE WT	2692607.6
GLOW	4817348.7
EFFECTIVE STG 1 LAMBDA	.92816
EFFECTIVE STG 2 LAMBDA	.92097

CONVERGENCE DATA:

GLOW	4817349.	
THROW WEIGHT		417338.
PAYLOAD		132044.
TOTAL VIDEAL	30307.8	
STAGE 1 VIDEAL		10997.9
STAGE 2 VIDEAL		19309.9
TOTAL PROPELLANT	4166001.	
LRB PROPELLANT		2458513.
ET PROPELLANT		1707488.

STAGE 1 SIZING DATA

AVERAGE SP. IMP.	346.03
LIFT-OFF T/W	1.236
MAXIMUM Q	509.9
TIME AT MAX Q	80.0
STG 1 MAX LF	3.00
TIME AT MAX LF	159.0
EFF WDOT/LRB	14692.6
EFF WDOT/EVENT 1	18068.9

STAGING CONDITIONS:

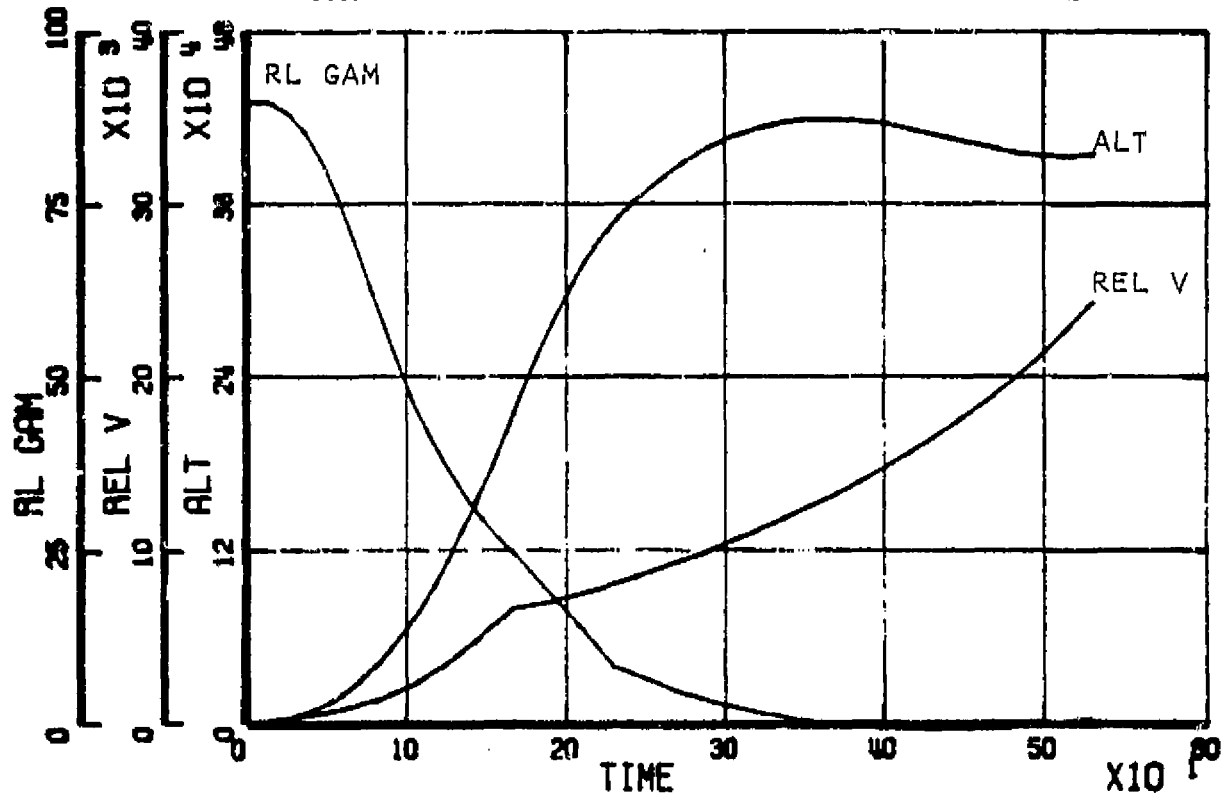
WEIGHT	1793884.
REL VELOCITY (FPS)	6414.5
REL F.P. ANGLE (DEG)	24.97
ALTITUDE (FT)	207760.
TIME (SEC)	167.33
ATT AFTER STG (DEG)	1.13

MISSION SUMMARY: OCTOBER 10, 1975

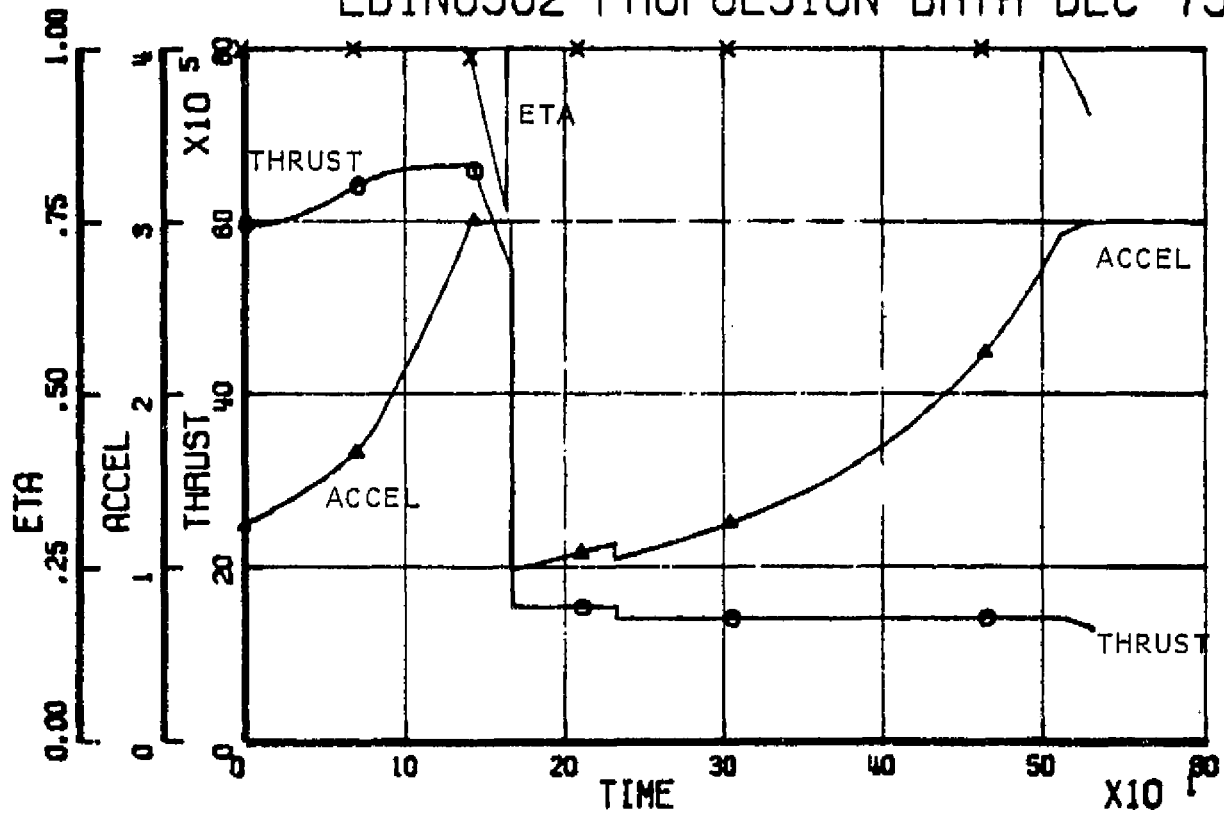
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4
TIME (SEC)	167.3	236.5	531.0	606.0
ALTITUDE (K FT)	207.8	348.6	394.4	0
REL VELOCITY (100 FPS)	64.1	81.4	243.0	201.3
REL GAMMA (DEG)	25.0	8.27	.528	-89.8
WEIGHT (K LBS)	4817.3	1559.9	1326.4	234.0
WEIGHT DROP (K LBS)	234.0	0	0	0
THROW WEIGHT (K LBS)	1559.9	1326.4	417.34	0
CUM VIDEAL (100 FPS)	110.0	133.7	303.1	0
DOWNRANGE (NMI)	45.1	132.7	912.0	286.2

EVENT 1	BECD/SEPARATION	EVENT 3	MECD/INJECTION
EVENT 2	RTLS/ADA CONSTRAINT	EVENT 4	LRB TOUCHDOWN

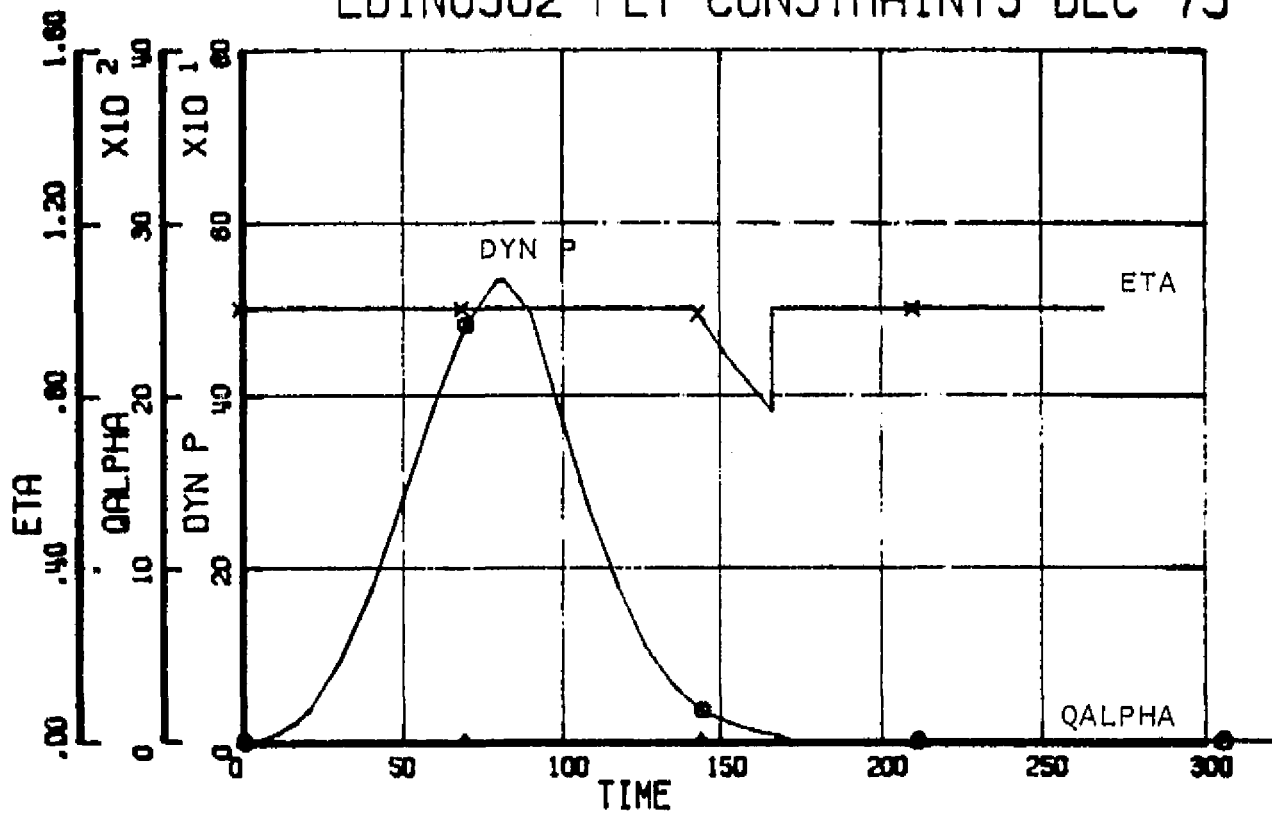
EDIN0502 LAUNCH STATE 16 DEC 75



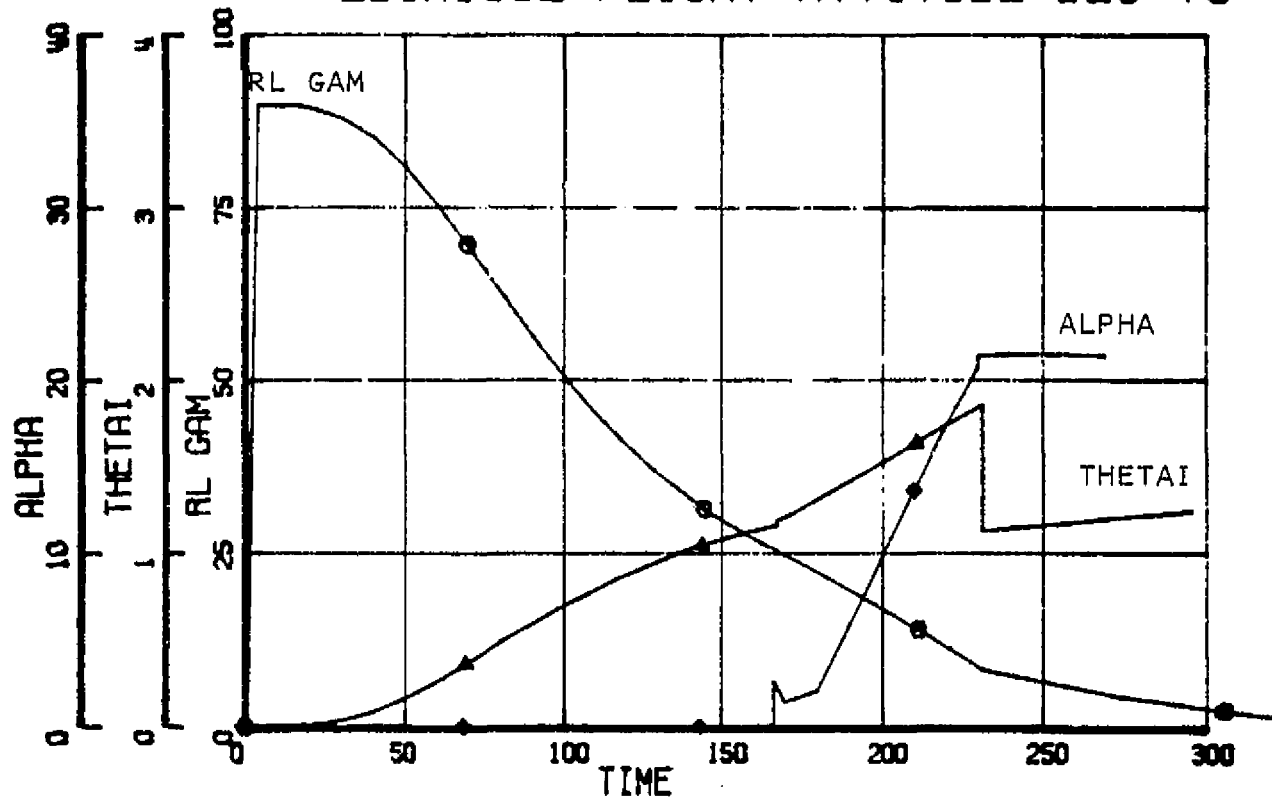
EDIN0502 PROPULSION DATA DEC 75



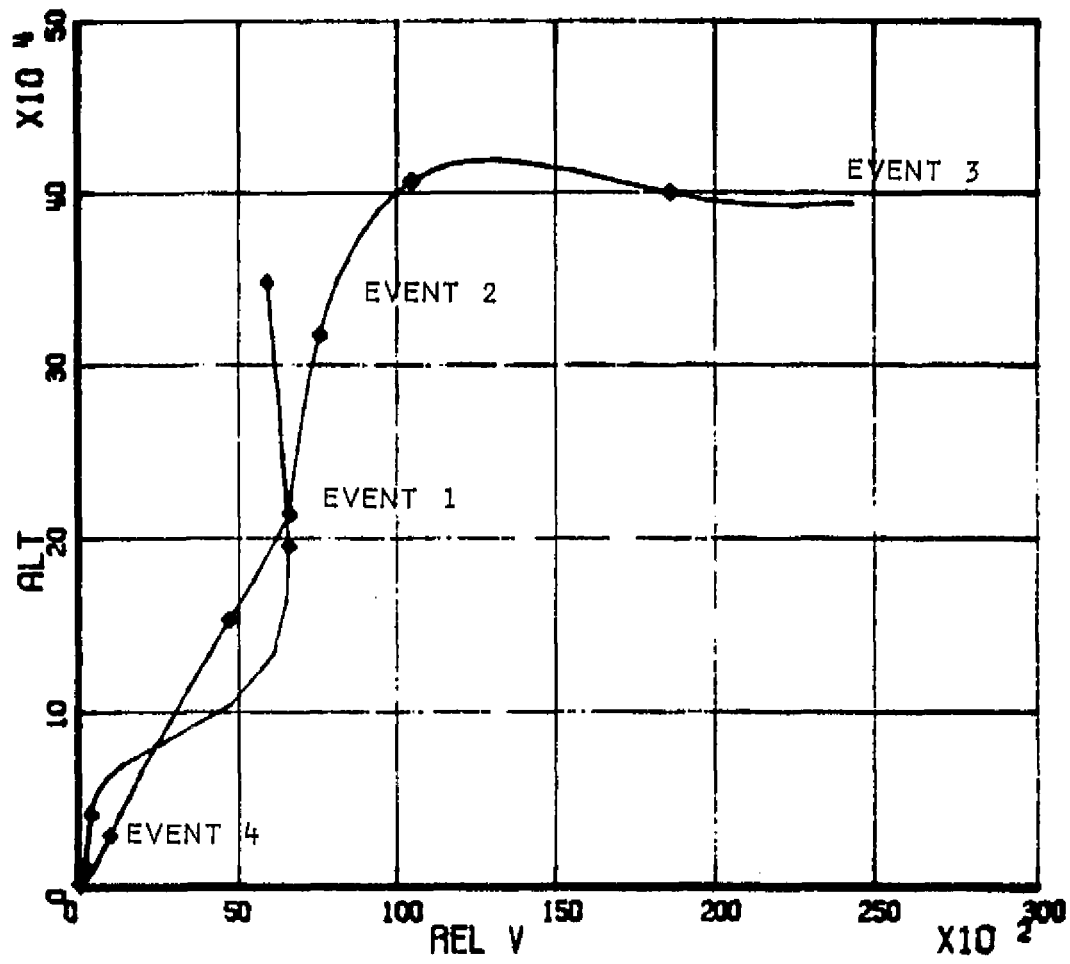
EDIN0502 FLT CONSTRAINTS DEC 75



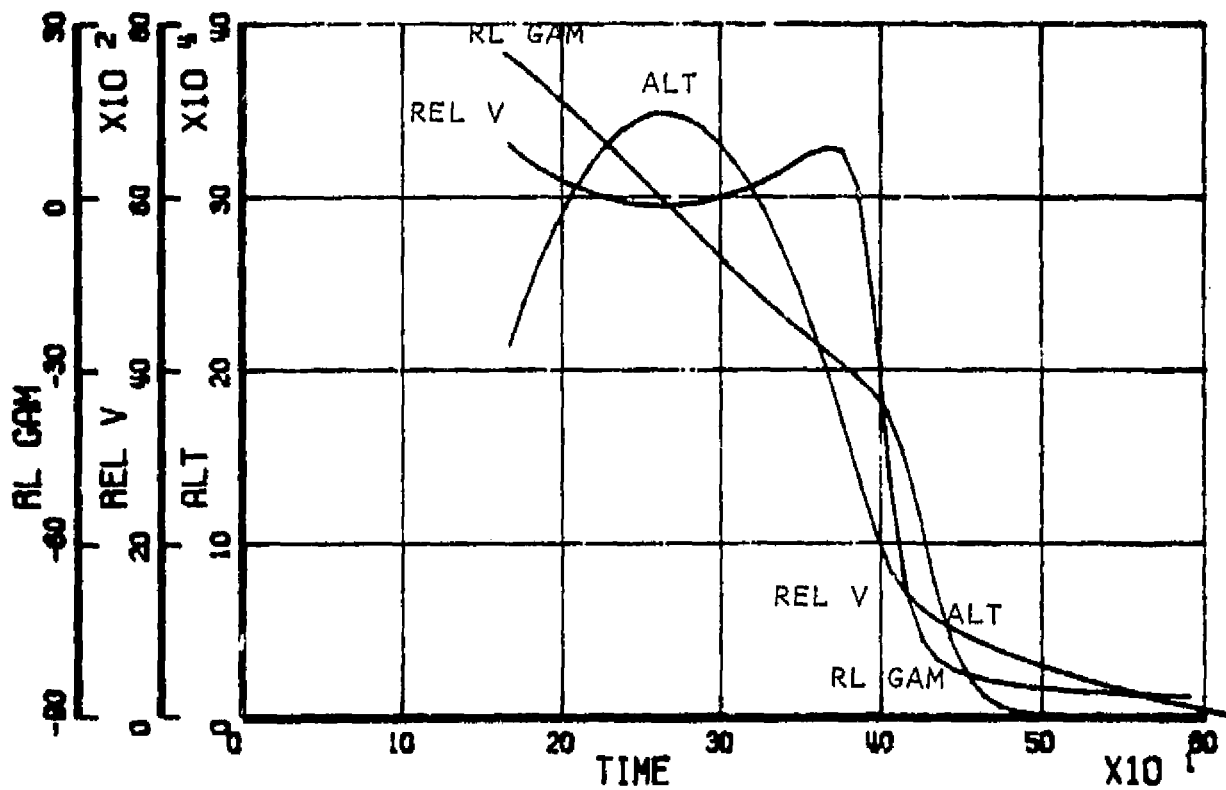
EDIN0502 FLIGHT ATTITUDE DEC 75



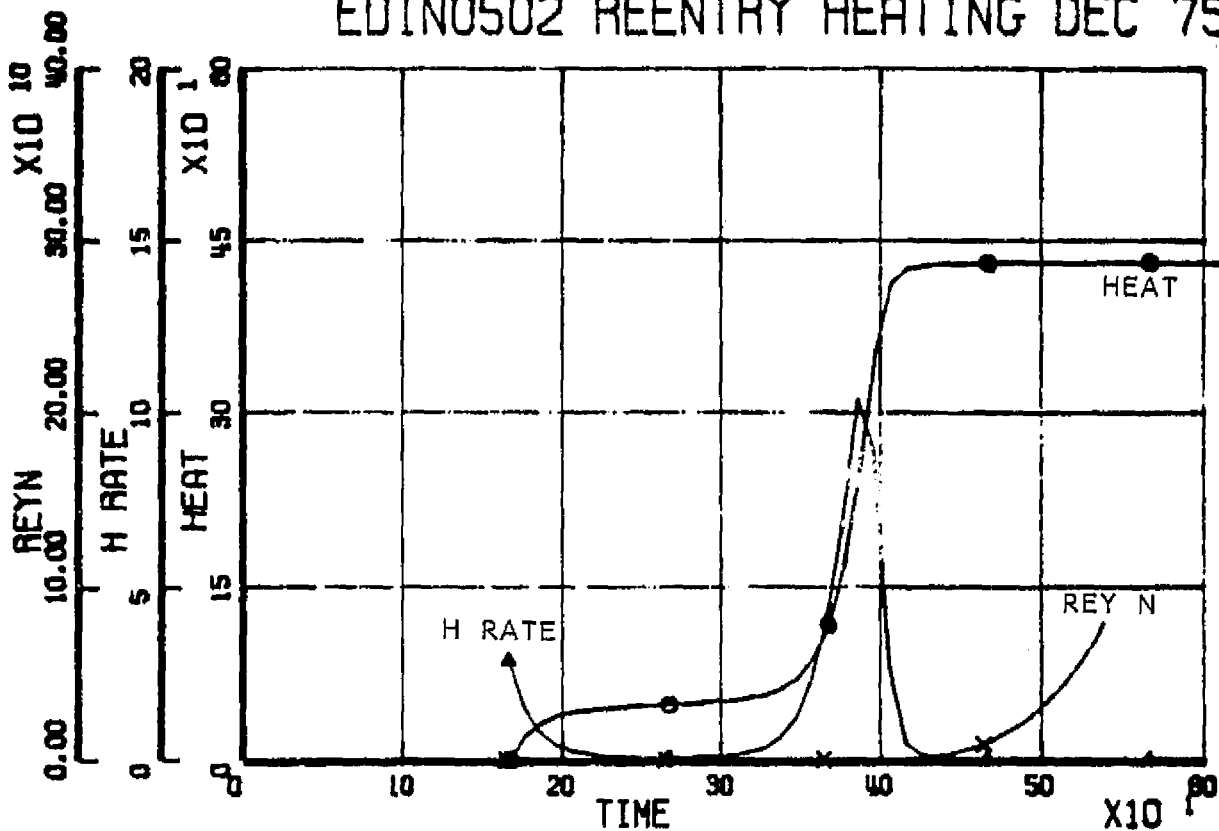
EDIN0502 H-V PROFILE 16 DEC 75



EDIN0502 LRB REENTRY STATE DEC 75



EDIN0502 REENTRY HEATING DEC 75



SIGMA CORPORATION

EDIN0502B DESIGN
SIMULATION RESULTS

FORECASTER: EDIN DESIGN CENTER DATE: 10 OCT 75
AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC TIME: 17:07
STUDY NO: EDIN0502

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 7.00 HIGH
PRESSURE ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR
REPLACEMENT OF THE SOLID ROCKET BOOSTERS.

MISSION: MAXIMUM PAYLOAD
DUE EAST LAUNCH FROM ETR
A 250 FPS OMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL
MILE REFERENCE ORBIT.
A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED EXO-ATMOSPHERIC PITCH
PROFILE AND INITIAL TILT RATE.
MID POINT CONSTRAINT = SHUTTLE MISSION 1 RTLS/ROA
END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
ATMOSPHERIC INFLIGHT CONSTRAINTS CONTROLLED BY HIGH
PRESSURE ENGINE THROTTLING AND/OR SSME THROTTLING.
MAX DYNAMIC PRESSURE = 650.0 PSF
MAX ACCELERATION = 3.0 G

PROPULSION: LRB: 7.00 HIGH PRESSURE ENGINES RATED AS FOLLOWS:

THRUST(SL) = 680000.00 LBS
THRUST(VAC) = 735300.00 LBS
THROTTLE = 1.00 TO .500
ISP(SL) = 319.60 SEC.
ISP(VAC) = 345.60 SEC.
FLOWRATE = 2127.7 LB/SEC
EXIT AREA = 27.122 SQ FT
MIX RATIO = 2.40:1

ORBITER: THREE SSME ENGINES RATED AS FOLLOWS:

THRUST(SL) = 375000.00 LBS
THRUST(VAC) = 470000.00 LBS
THROTTLE = 1.09 TO .500
ISP(SL) = 363.20 SEC
ISP(VAC) = 455.20 SEC
FLOWRATE = 1032.5 LB/SEC
EXIT AREA = 44.896 SQ FT
MIX RATIO = 6.00:1

AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION
WERE OBTAINED FROM SHUTTLE AERO ESTIMATES. ADJUSTMENTS
WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
REF AREA = 2557.0 SQ FT

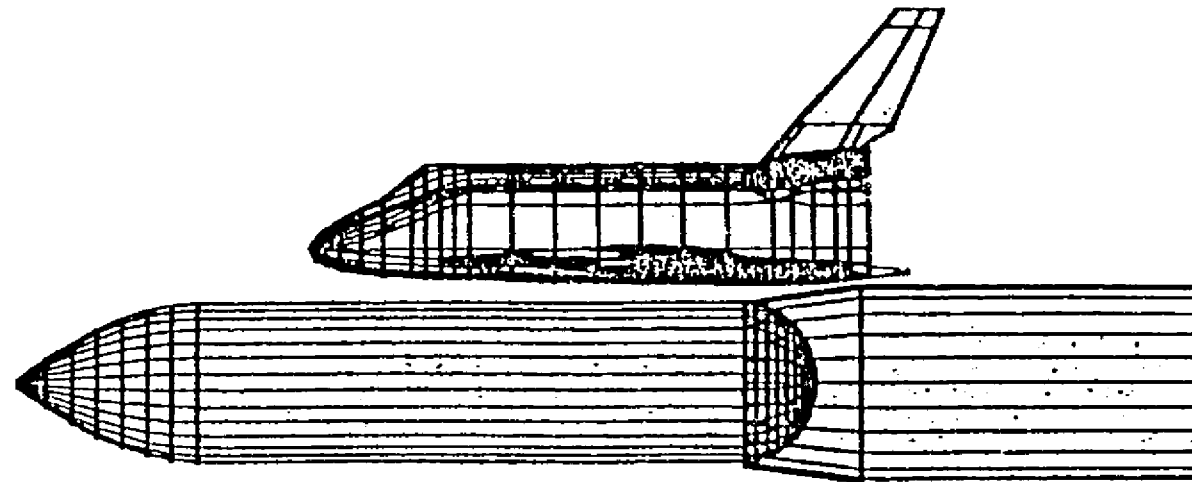
STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS
ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND
INCREASED UP PAYLOADS.

MASS
PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC
ASSUMPTIONS.

LRB: WERS BASED ON SATURN TECHNOLOGY.
ET: FIXED MASS FRACTION DISTRIBUTED IN
ACCORDANCE WITH SHUTTLE ET WEIGHT
STATEMENT.

ORBITER: FEB 1975 SHUTTLE WITH MODS FOR
INCREASED UP PAYLOAD.

EDIN0502B DESIGN SIMULATION RESULTS.



WEIGHTS SUMMARY REPORT

GLOW	4927992.12
ET LIFT-OFF WEIGHT	1911240.42
ET INERT WEIGHT	104144.4
ET PROPELLANT	1807098.00
LRB LIFT-OFF WEIGHT	2692607.81
LRB INERT WEIGHT	234010.25
LRB PROPELLANT	2458597.56
ORBITER LIFT-OFF WEIGHT	324144.00
ORBITER INERT WEIGHT	187254.00
PAYLOAD	136881.36

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	2862.	
BODY GROUP	43291.	
INDUCED ENVIRN PROTECT	19874.	
LANDING & AUX SYSTEMS	7683.	
PROPULSION-ASCENT	28054.	
PROPULSION-RCS	2657.	
PROPULSION-OMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2739.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 100K PAYLD	390.	
ORBITER EMPTY WEIGHT		151715.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	5024.	
PROPELLANT-RCS	6241.	
PROPELLANT-OMS	16149.	
ORBITER INERT WEIGHT		167254.
PAYLOAD		136890.
ORBITER PRELAUNCH WEIGHT		324144.

EXTERNAL TANK WEIGHT STATEMENT:

LOX TANK		17208.
BHD	84.	
FWD FRAME	54.	
FWD OGIVE	1420.	
AFT OGIVE	4774.	
XT 745 FRAME	331.	
BARREL	3087.	
INTERTANK FRAME	1126.	
AFT DOME	3671.	
SLOSH BAFFLES	2660.	
INTERTANK		13449.
MACHINED BARREL PNLS	5385.	
SK/STGR BARREL PNLS	5821.	
STABILIZING FRAMES(4)	1593.	
SRB THRST XT 985 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	72.	
BARREL PNLS SPLICES (8)	119.	
FRAME STABLIZERS	258.	
ET ASSY FASTENERS	202.	

LH2 TANK		42216.
FWD DOME	2013.	
XT 1129.9 FRAME	1927.	
BARREL NO.4	6905.	
XT 1377 FRAME	692.	
BARREL NO.3	6942.	
XT 1624 FRAME	693.	
BARREL NO.2	6946.	
XT 1871 FRAME	2176.	
BARREL NO.1	7347.	
XT 2058 FRAME	4159.	
AFT DOME	2355.	
THERMAL PROTECTION		8180.
LOX TANK	1754.	
INTERTANK	1821.	
LH2 TANK	4273.	
PROP (MECH+ELEC)	333.	
PROPULSION AND MECHANICAL SYSTEMS		4766.
LOX FEED SYS	2038.	
LOX ANTIGEEYER SYS	191.	
LOX VENT SYS	107.	
LOX PRESS. SYS	232.	
LH2 FEED SYS	583.	
LH2 RECIR. SYS	38.	
LH2 VENT SYS	162.	
LH2 PRESS. SYS	172.	
HELIUM INJ. SYS	26.	
INTERTANK PURGE SYS	101.	
HAZARD GAS DETECTION SYS	10.	
FAIRINGS AND CONDUIT	431.	
LINE SUPTS. AND ATTACHS.	675.	
ELECTRICAL SYSTEM		295.
ET WIRING ASSY	199.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	18.	
CABLING ATTACHS.+SENSOR SUPTS.	77.	
ORB/SRB ATTACHMENTS		5670.
ORBITER SUPPORTS	3891.	
UMBILICAL BEAM	798.	
ORB/ET ATTACH FTGS	296.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL HDWR	685.	
MANUFACTURING VARIATION WT.		536.
EMPTY WEIGHT		92321.
UNUSABLE FLUIDS		515.
LH2 IN TANK	289.	
LH2 IN LINE	59.	
LOX IN LINE	166.	
PRE-PRESS.+INFLIGHT GASES		4662.
GH2	1212.	
GOX	3411.	
HELIUM	39.	
SEPARATION HARDWARE		6.
SRB SUPPORTS	0.	
ORB FITTINGS	6.	
FLT PERF RES		6641.
ET INERT WT		104144.
MAIN PROPELLANTS		1807096.
LOX	1548939.	
LH2	258157.	
ET LIFT-OFF WEIGHT		1911240.
MASS FRACTION		.9490

LIQUID POCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		93058.
INTEGRAL LOX TANK	20679.	
INTEGRAL FUEL TANK	14022.	
INTERSTAGE	8583.	
AFT SKIRT	16159.	
THRUST STRUCTURE	33615.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		2189.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1248.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		799.
ELECTRICAL SYSTEM	684.	
CONTROL SYSTEM	115.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		68208.
ENGINES (DRY)	37345.	
ACCESSORIES	416.	
GIMBAL SYSTEM	5283.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	8389.	
OXIDIZER SYSTEM	12419.	
SEPARATION AND RECOVERY SYSTEM		16665.
SEPARATION SYSTEM	2488.	
CHUTE SYS (MAIN AND DROGUE)	5724.	
FLOATATION SYSTEM	104.	
RECOVERY AIDS	102.	
FITTINGS AND SUPPORTS	197.	
RETRO SYS (100 F/S DEL V)	3174.	
REENTRY HEAT SHIELD	4876.	
STAGE DRY WEIGHT		189356.
CONTINGENCY		0.
EMPTY WEIGHT		189356.
PROPELLANT RESIDUALS		40383.
FUEL BIAS	1800.	
TRAPPED LOX TANK GASES	3871.	
TRAPPED FUEL TANK GASES	3440.	
FROST TRAPPED	434.	
TRAPPED FUEL	12160.	
TRAPPED LOX	18073.	
IN-FLIGHT LOSSES		4271.
FUEL LOSSES	1956.	
LOX LOSSES	2229.	
MAIN PROPELLANTS		2458598.
FUEL	719124.	
LOX	1739474.	
BLOW		2692608.
MASS FRACTION (BASED ON INERT WT)		.9131

ORBITER WT	324144.0
ET WEIGHT	1911240.4
LRB STAGE WT	2692607.8
BLOW	4927992.2
EFFECTIVE STG 1 LAMBDA	.92807
EFFECTIVE STG 2 LAMBDA	.92289

CONVERGENCE DATA:

GLOW	4928000.	
THROW WEIGHT		428280.
PAYLOAD		136881.
TOTAL VIDEAL	30515.0	
STAGE 1 VIDEAL		10543.7
STAGE 2 VIDEAL		19971.3
TOTAL PROPELLANT	4265710.	
LRB PROPELLANT		2458612.
ET PROPELLANT		1807098.

STAGE 1 SIZING DATA

AVERAGE SP. IMP.	345.50
LIFT-OFF T/W	1.209
MAXIMUM Q	487.8
TIME AT MAX Q	90.0
STG 1 MAX LF	3.00
TIME AT MAX LF	166.1
EFF WDOT/LRB	14805.6
EFF WDOT/EVENT 1	18181.9

ORIGINAL PAGE 1.
OF POOR QUALITY

STAGING CONDITIONS:

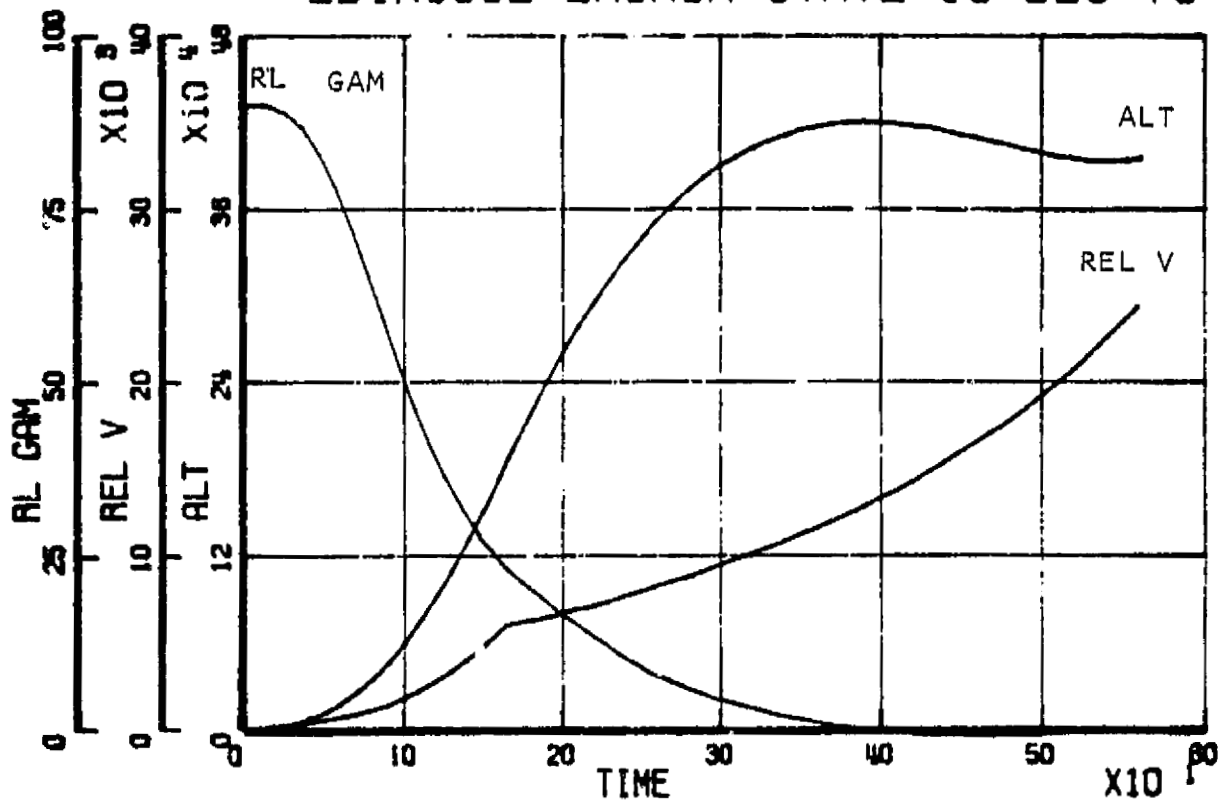
WEIGHT	1908724.
REL VELOCITY (FPS)	5989.8
REL F.P. ANGLE (DEG)	23.43
ALTITUDE (FT)	185554.
TIME (SEC)	166.06
ATT AFTER STG (DEG)	.99

MISSION SUMMARY: OCTOBER 10, 1975

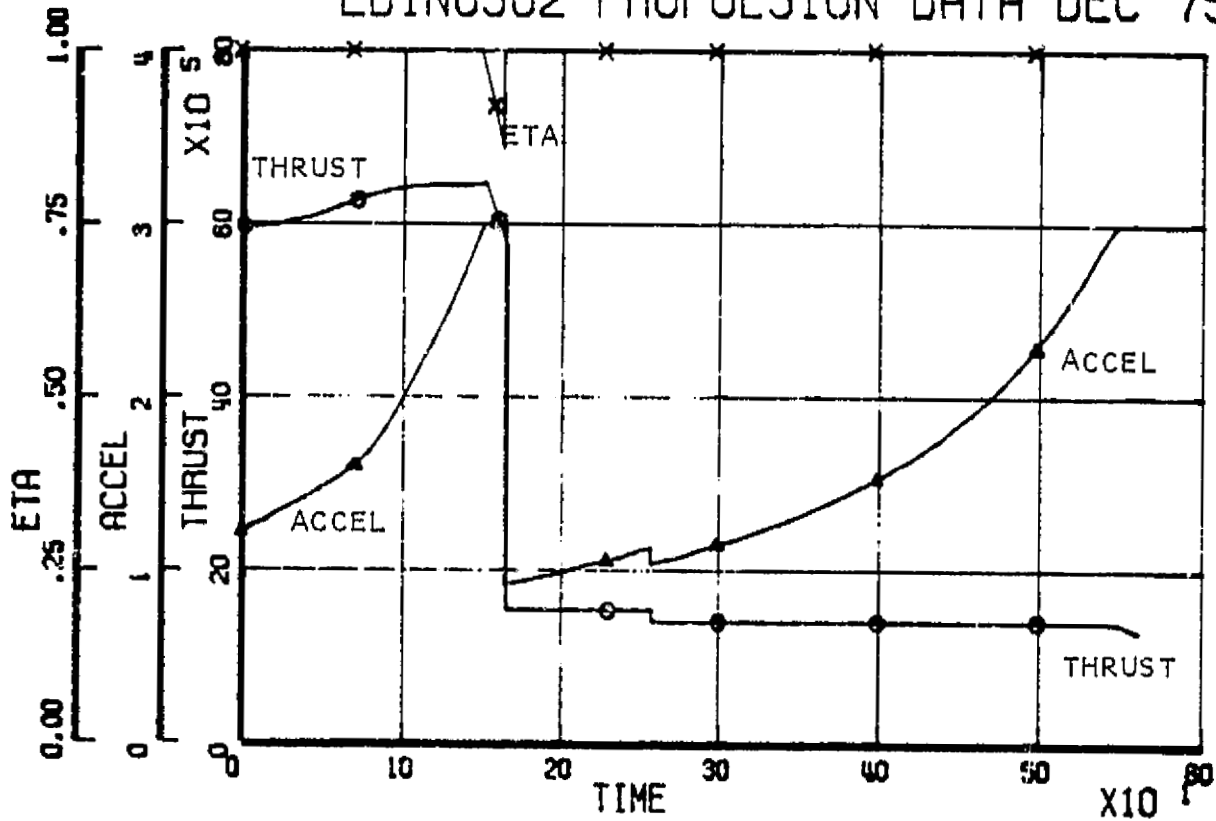
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4
TIME (SEC)	166.1	257.2	560.9	578.3
ALTITUDE (K FT)	185.6	348.6	394.4	0
REL VELOCITY (100 FPS)	59.9	81.4	243.0	201.3
REL GAMMA (DEG)	23.4	8.27	.529	-89.8
WEIGHT (K LBS)	4928.0	1674.7	1367.0	234.0
WEIGHT DROP (K LBS)	234.0	0	0	0
THROW WEIGHT (K LBS)	1674.7	1367.0	428.28	0
CUM VIDEAL (100 FPS)	105.4	135.2	305.1	0
DOWNRANGE (NMI)	40.9	153.5	954.5	236.9

EVENT 1	BECD/SEPARATION	EVENT 3	MECD/INJECTION
EVENT 2	RTLS/ROA CONSTRAINT	EVENT 4	LRB TOUCHDOWN

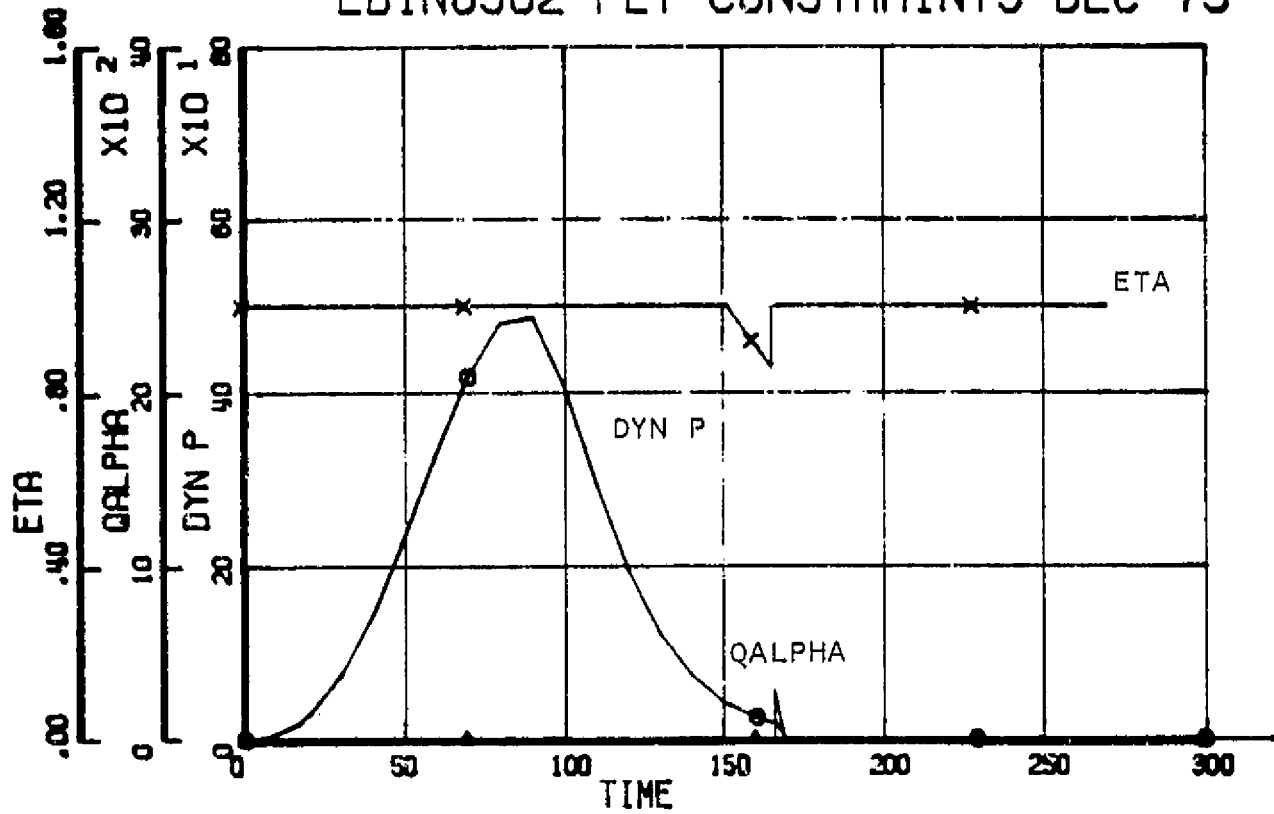
EDIN0502 LAUNCH STATE 16 DEC 75



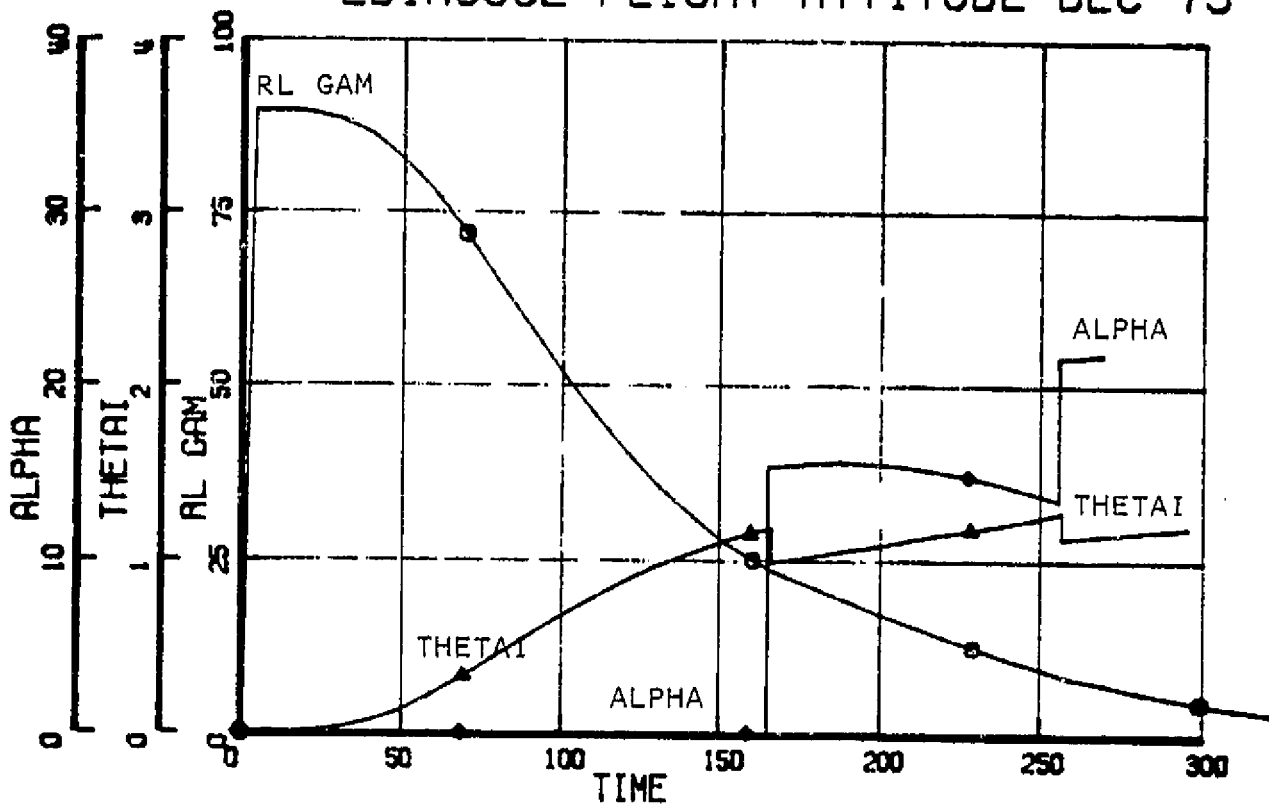
EDIN0502 PROPULSION DATA DEC 75



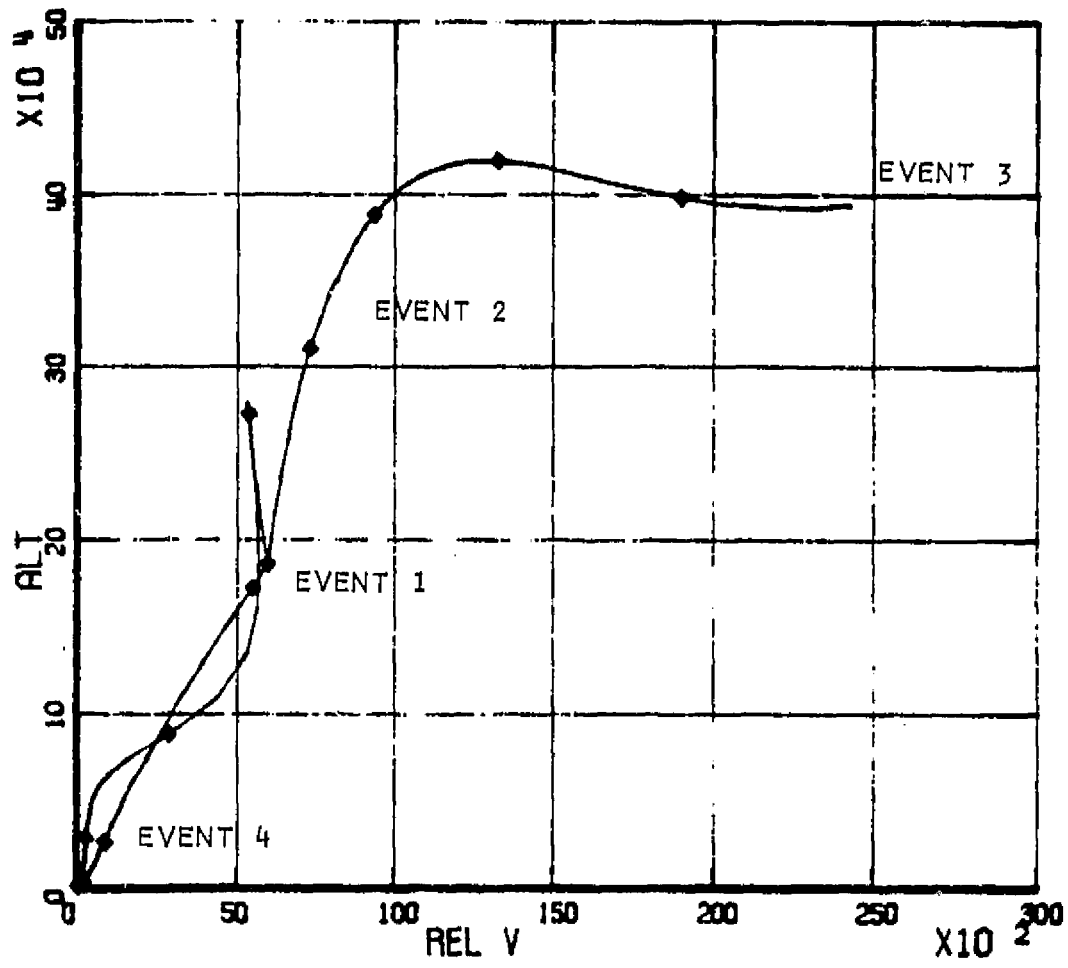
EDIN0502 FLT CONSTRAINTS DEC 75



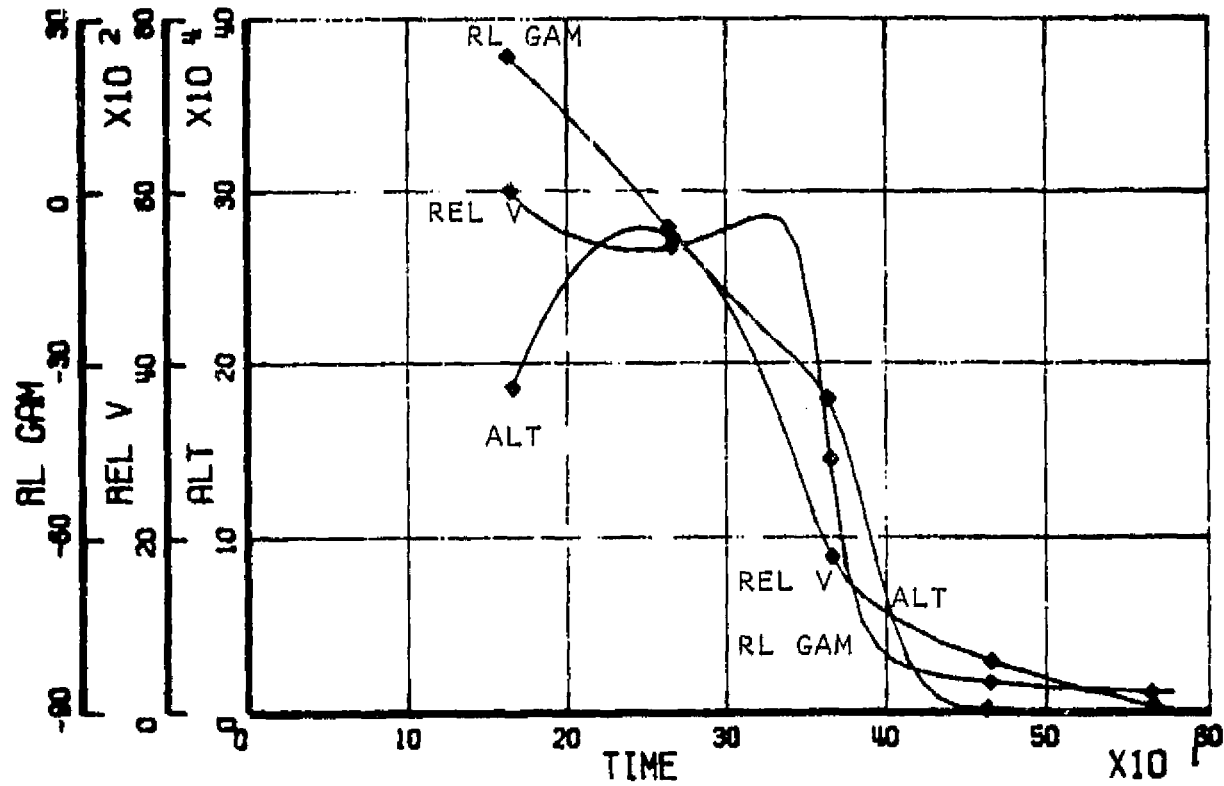
EDIN0502 FLIGHT ATTITUDE DEC 75



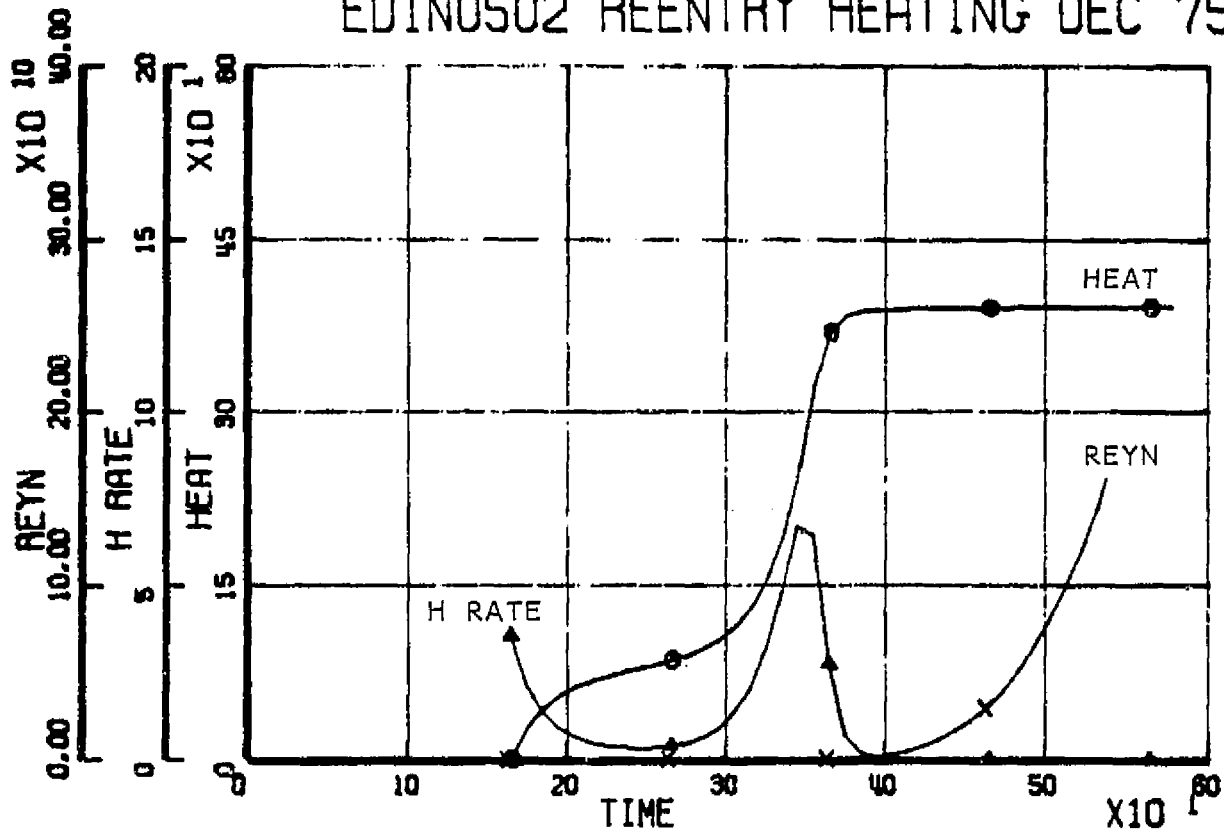
EDIN0502 H-V PROFILE 16 DEC 75



EDIN0502 LRB REENTRY STATE DEC 75



EDIN0502 REENTRY HEATING DEC 75



SIGMA CORPORATION

EDIN0503 DESIGN
SIMULATION RESULTS

 FORECASTER: EDIN DESIGN CENTER DATE: 10 OCT 75
 AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC TIME: 19:07
 STUDY NO: EDIN0503

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 6.00 HIGH PRESSURE ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR REPLACEMENT OF THE SOLID ROCKET BOOSTERS.

MISSION: MAXIMUM PAYLOAD
 DUE EAST LAUNCH FROM ETP
 A 250 FPS OMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL MILE REFERENCE ORBIT.
 A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED EXO-ATMOSPHERIC PITCH PROFILE AND INITIAL TILT RATE.
 MID POINT CONSTRAINT = SHUTTLE MISSION 1 PTLC/AOR
 END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
 ATMOSPHERIC INFIGHT CONSTRAINTS CONTROLLED BY HIGH PRESSURE ENGINE THROTTLING AND/OR SOME THROTTLING.
 MAX DYNAMIC PRESSURE = 650.0 PCF
 MAX ACCELERATION = 3.0 G

PROPULSION: LRB: 6.00 HIGH PRESSURE ENGINES RATED AS FOLLOWS:

THRUST(SL) = 800000.00 LBS
 THRUST(VAC) = 856800.00 LBS
 THROTTLE = 1.00 TO .500
 ISP(SL) = 327.60 SEC.
 ISP(VAC) = 350.80 SEC.
 FLOWRATE = 2442.2 LB/SEC
 EXIT AREA = 31.730 SQ FT
 MIX RATIO = 2.90:1

ORBITER: THREE SOME ENGINES RATED AS FOLLOWS:

THRUST(SL) = 375000.00 LBS
 THRUST(VAC) = 470000.00 LBS
 THROTTLE = 1.09 TO .500
 ISP(SL) = 363.20 SEC
 ISP(VAC) = 455.20 SEC
 FLOWRATE = 1032.5 LB/SEC
 EXIT AREA = 44.896 SQ FT
 MIX RATIO = 6.00:1

AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION WERE OBTAINED FROM SHUTTLE AERO ESTIMATES. ADJUSTMENTS WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
 REF AREA = 2557.0 SQ FT

STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND INCREASED UP PAYLOADS.

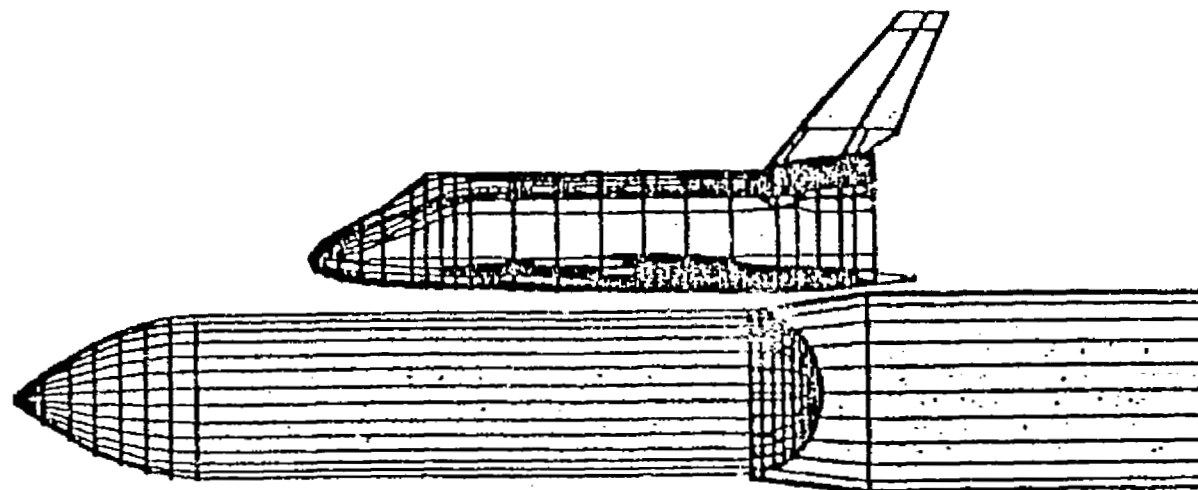
MASS PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC ASSUMPTIONS.

LRB: WERS BASED ON SATURN TECHNOLOGY.
 ET: FIXED MASS FRACTION DISTRIBUTED IN ACCORDANCE WITH SHUTTLE ET WEIGHT STATEMENT.

ORBITER: FEB 1975 SHUTTLE WITH MODS FOR INCREASED UP PAYLOAD.

EDIN0503 DESIGN SIMULATION RESULTS

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WEIGHTS SUMMARY REPORT

GLOW	4697514.81
ET LIFT-OFF WEIGHT	1805487.20
ET INERT WEIGHT	98039.26
ET PROPELLANT	1707528.81
LRB LIFT-OFF WEIGHT	2568623.78
LRB INERT WEIGHT	234013.29
LRB PROPELLANT	2334610.50
ORBITER LIFT-OFF WEIGHT	323404.00
ORBITER INERT WEIGHT	187254.00
PAYLOAD	136122.01

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	2862.	
BODY GROUP	43291.	
INDUCED ENVIRN PROTECT	19874.	
LANDING & AUX SYSTEMS	7683.	
PROPULSION-ASCENT	28054.	
PROPULSION-RCS	2657.	
PROPULSION-OMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2739.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 100K PAYLD	390.	
ORBITER EMPTY WEIGHT		151715.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	5024.	
PROPELLANT-RCS	6241.	
PROPELLANT-OMS	16149.	
ORBITER INERT WEIGHT		187254.
PAYLOAD		136150.
ORBITER PRELAUNCH WEIGHT		323404.

EXTERNAL TANK WEIGHT STATEMENT:

LOX TANK		16260.
BHD	79.	
FWD FRAME	51.	
FWD OSIVE	1342.	
AFT OSIVE	4511.	
XT 745 FRAME	313.	
BARREL	2917.	
INTERTANK FRAME	1064.	
AFT DOME	3469.	
CLOSH BAFFLES	2514.	
INTERTANK		12708.
MACHINED BARREL PNLS	5088.	
SK/STGR BARREL PNLS	5500.	
STABILIZING FRAMES(4)	1505.	
SRB THRST XT 985 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	68.	
BARREL PNLS SPLICES (8)	113.	
FRAME STABLIZERS	244.	
ET ASSY FASTENERS	191.	

LH2 TANK		29688.
FND DOME	1902.	
MT 1129.9 FRAME	1877.	
BARREL NO.4	6525.	
MT 1377 FRAME	655.	
BARREL NO.3	6559.	
MT 1624 FRAME	655.	
BARREL NO.2	6563.	
MT 1871 FRAME	2056.	
BARREL NO.1	6942.	
MT 2058 FRAME	3929.	
AFT DOME	2225.	
THERMAL PROTECTION		7729.
LOX TANK	1657.	
INTERTANK	1720.	
LH2 TANK	4037.	
PROP (MECH+ELEC)	314.	
PROPULSION AND MECHANICAL SYSTEMS		4504.
LOX FEED SYS	1928.	
LOX ANTIGEYER SYS	181.	
LOX VENT SYS	101.	
LOX PRESS. SYS	219.	
LH2 FEED SYS	551.	
LH2 RECIR. SYS	36.	
LH2 VENT SYS	153.	
LH2 PRESS. SYS	162.	
HELIUM INJ. SYS	25.	
INTERTANK PURGE SYS	95.	
HAZARD GAS DETECTION SYS	10.	
PAIRINGS AND CONDUIT	407.	
LINE SUPTS. AND ATTACHS.	637.	
ELECTRICAL SYSTEM		278.
ET WIRING ASSY	188.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	17.	
CABLING ATTACHS.+SENSOR SUPTS.	73.	
ORB/SRB ATTACHMENTS		5358.
ORBITER SUPPORTS	3677.	
UMBILICAL BEAM	754.	
ORB/ET ATTACH FTGS	280.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL HDWR	647.	
MANUFACTURING VARIATION WT.		506.
EMPTY WEIGHT		87230.
UNUSABLE FLUIDS		1486.
LH2 IN TANK	273.	
LH2 IN LINE	56.	
LOX IN LINE	157.	
PRE-PRESS.+INFLIGHT GASES		4405.
GH2	1145.	
GOX	3223.	
HELIUM	37.	
SEPARATION HARDWARE		-6.
SRB SUPPORTS	0.	
ORB FITTINGS	6.	
FLT PERF RES		5912.
ET INERT WT		98039.
MAIN PROPELLANTS		1707448.
LOX	1463527.	
LH2	243921.	
ET LIFT-OFF WEIGHT		1805487.
MASS FRACTION		.9490

LIQUID ROCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		93058.
INTEGRAL LOX TANK	20679.	
INTEGRAL FUEL TANK	14022.	
INTERSTAGE	8583.	
AFT SKIRT	16159.	
THRUST STRUCTURE	33815.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		2189.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1248.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		799.
ELECTRICAL SYSTEM	684.	
CONTROL SYSTEM	115.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		68963.
ENGINES (DRY)	38100.	
ACCESSORIES	416.	
GIMBAL SYSTEM	5283.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	8389.	
OXIDIZER SYSTEM	12419.	
SEPARATION AND RECOVERY SYSTEM		16665.
SEPARATION SYSTEM	2488.	
CHUTE SYS (MAIN AND DROGUE)	5724.	
FLOTATION SYSTEM	104.	
RECOVERY AIDS	102.	
FITTINGS AND SUPPORTS	197.	
RETRO SYS (100 F/S DEL V)	3174.	
REENTRY HEAT SHIELD	4876.	
STAGE DRY WEIGHT		190111.
CONTINGENCY		0.
EMPTY WEIGHT		190111.
PROPELLANT RESIDUALS		39767.
FUEL BIAS	1800.	
TRAPPED LOX TANK GASES	3871.	
TRAPPED FUEL TANK GASES	3440.	
FROST TRAPPED	434.	
TRAPPED FUEL	10064.	
TRAPPED LOX	18073.	
IN-FLIGHT LOSSES		4135.
FUEL LOSSES	1619.	
LOX LOSSES	2229.	
MAIN PROPELLANTS		2334611.
FUEL	595137.	
LOX	1739474.	
BLOW		2568624.
MASS FRACTION (BASED ON INERT WT)		.9089

ORBITER WT	323404.0
ET WEIGHT	1805487.2
LRB STAGE WT	2568623.8
GLOW	4697514.9
EFFECTIVE STG 1 LAMBDA	.92712
EFFECTIVE STG 2 LAMBDA	.92652

CONVERGENCE DATA:

GLOW	4697515.	
THROW WEIGHT		421415.
PAYLOAD		136122.
TOTAL VIDEAL	30170.5	
STAGE 1 VIDEAL		10779.6
STAGE 2 VIDEAL		19390.9
TOTAL PROPELLANT	4042026.	
LRB PROPELLANT		2334558.
ET PROPELLANT		1707529.

STAGE 1 SIZING DATA

AVERAGE SP. IMP.	352.91
LIFT-OFF T/W	1.277
MAXIMUM Q	541.6
TIME AT MAX Q	80.0
STG 1 MAX LF	3.00
TIME AT MAX LF	159.0
EFF WDOT/LRB	14460.1
EFF WDOT/EVENT 1	17836.4

STAGING CONDITIONS:

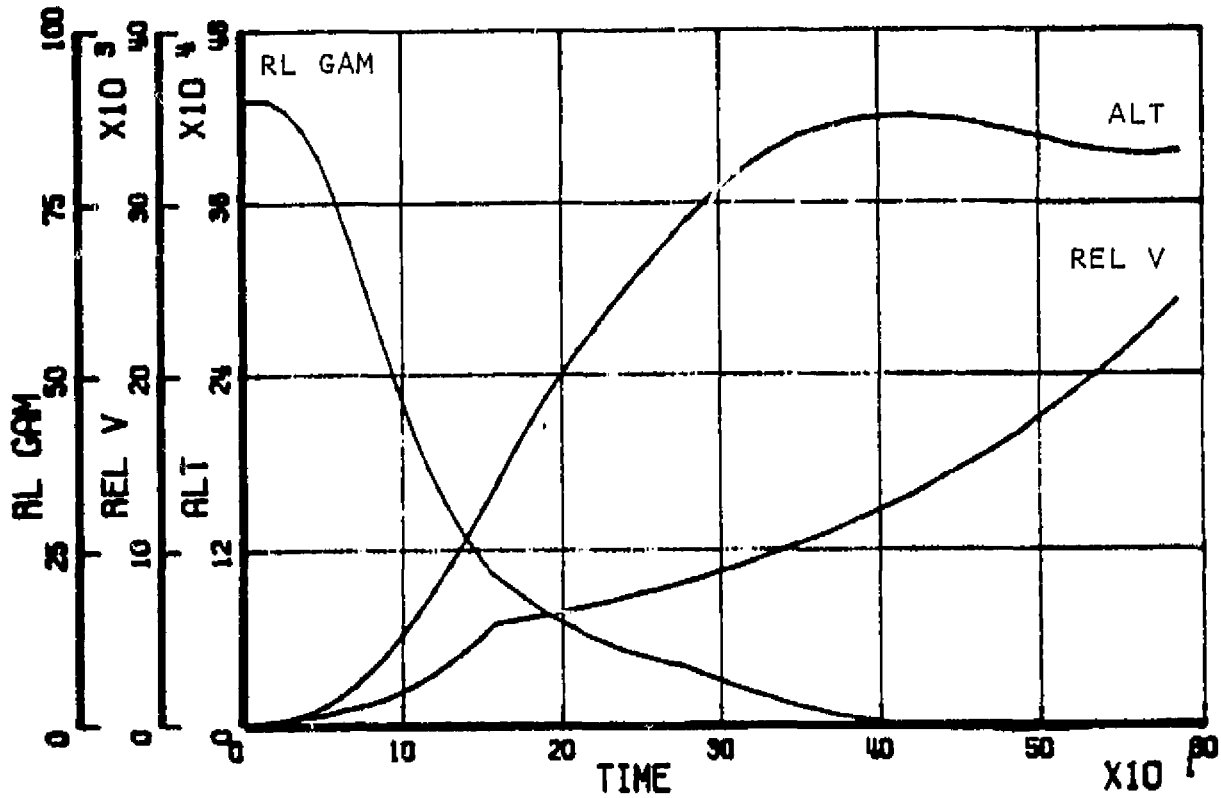
WEIGHT	1817865.
REL VELOCITY (FPS)	6368.4
REL F.P. ANGLE (DEG)	24.97
ALTITUDE (FT)	203542.
TIME (SEC)	161.45
ATT AFTER STG (DEG)	1.11

MISSION SUMMARY: OCTOBER 10, 1975

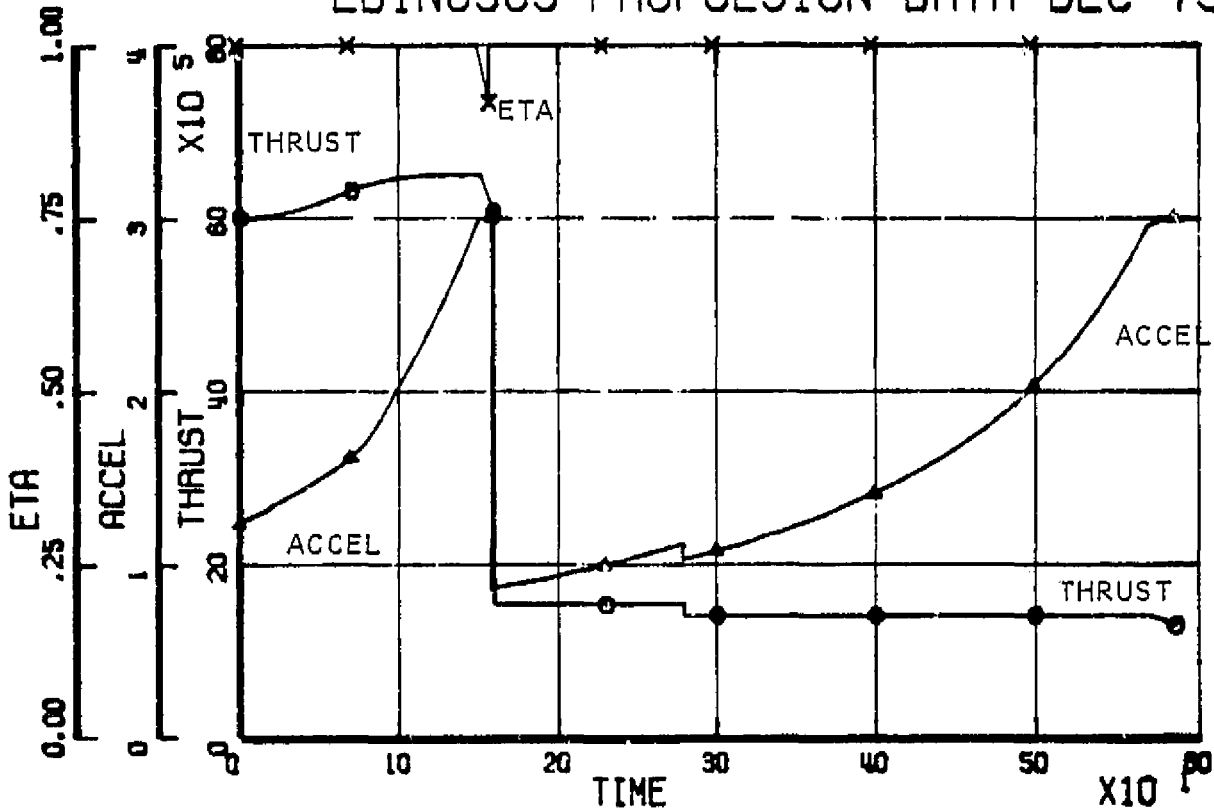
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4
TIME (SEC)	161.4	233.2	531.1	598.0
ALTITUDE (K FT)	203.5	348.6	394.4	0
REL VELOCITY (100 FPS)	63.7	81.4	243.0	201.3
REL GAMMA (DEG)	25.0	8.27	.528	-89.8
WEIGHT (K LBS)	4697.5	1583.9	1341.4	234.0
WEIGHT DROP (K LBS)	234.0	0	0	0
THROW WEIGHT (K LBS)	1583.9	1341.4	421.42	0
CUM VIDEAL (100 FPS)	107.8	132.1	301.7	0
DOWNRANGE (NMI)	44.4	135.2	922.7	280.3

EVENT 1	BECD/SEPARATION	EVENT 3	MECD/INJECTION
EVENT 2	RTLS/ADR CONSTRAINT	EVENT 4	LRB TOUCHDOWN

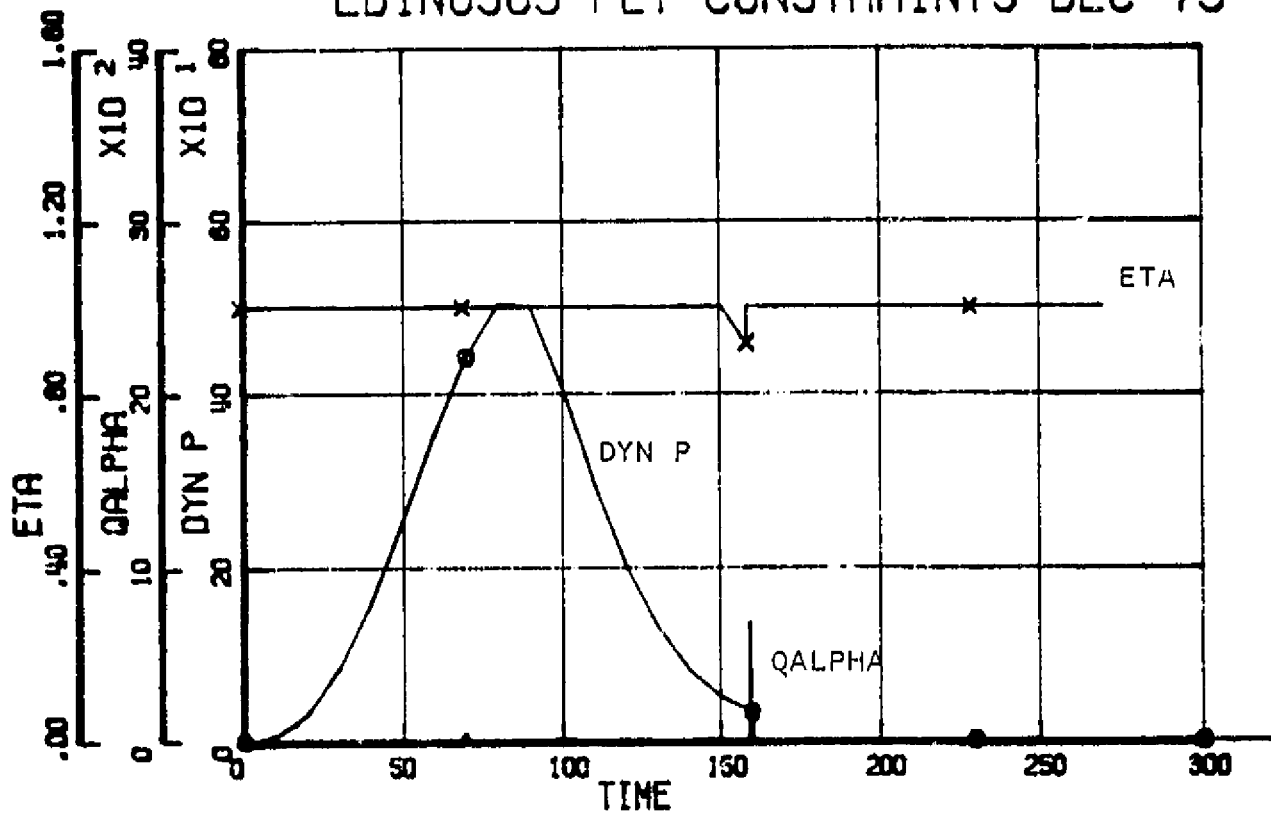
EDIN0503 LAUNCH STATE 16 DEC 75



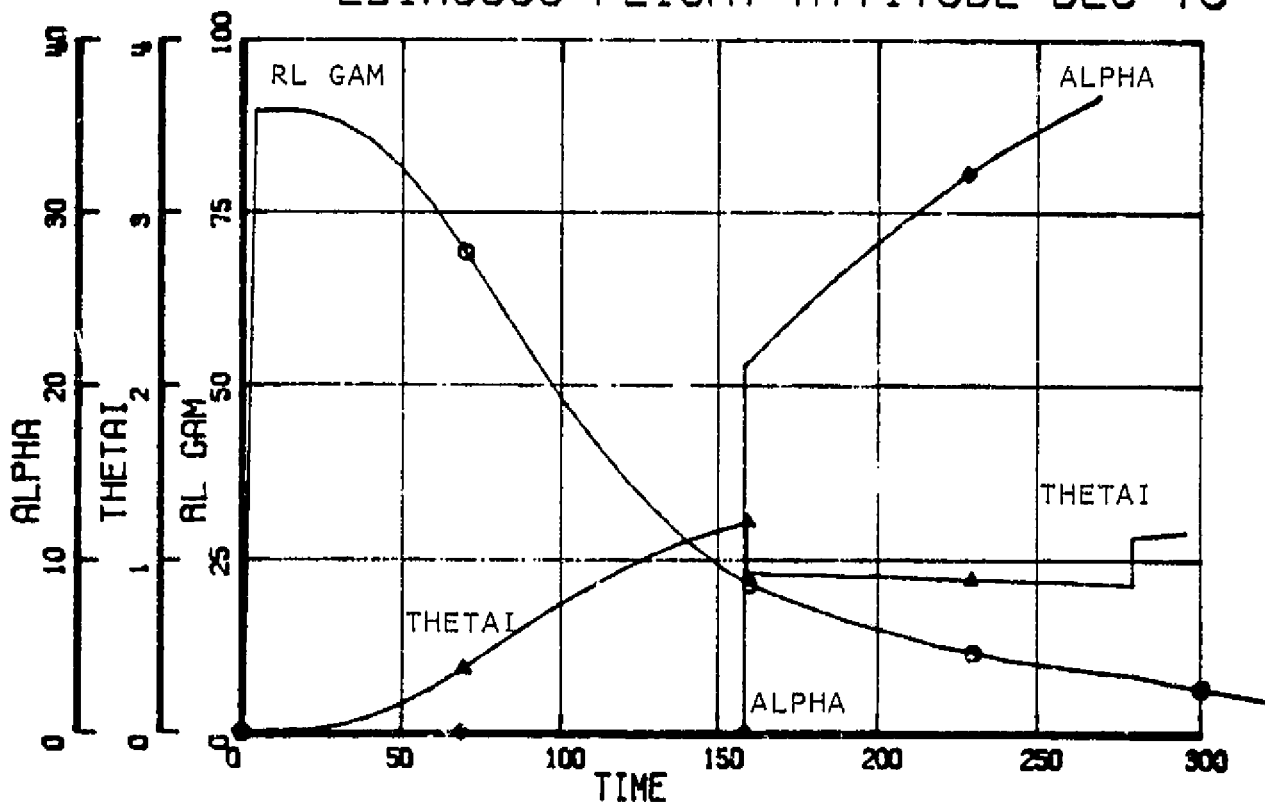
EDIN0503 PROPULSION DATA DEC 75



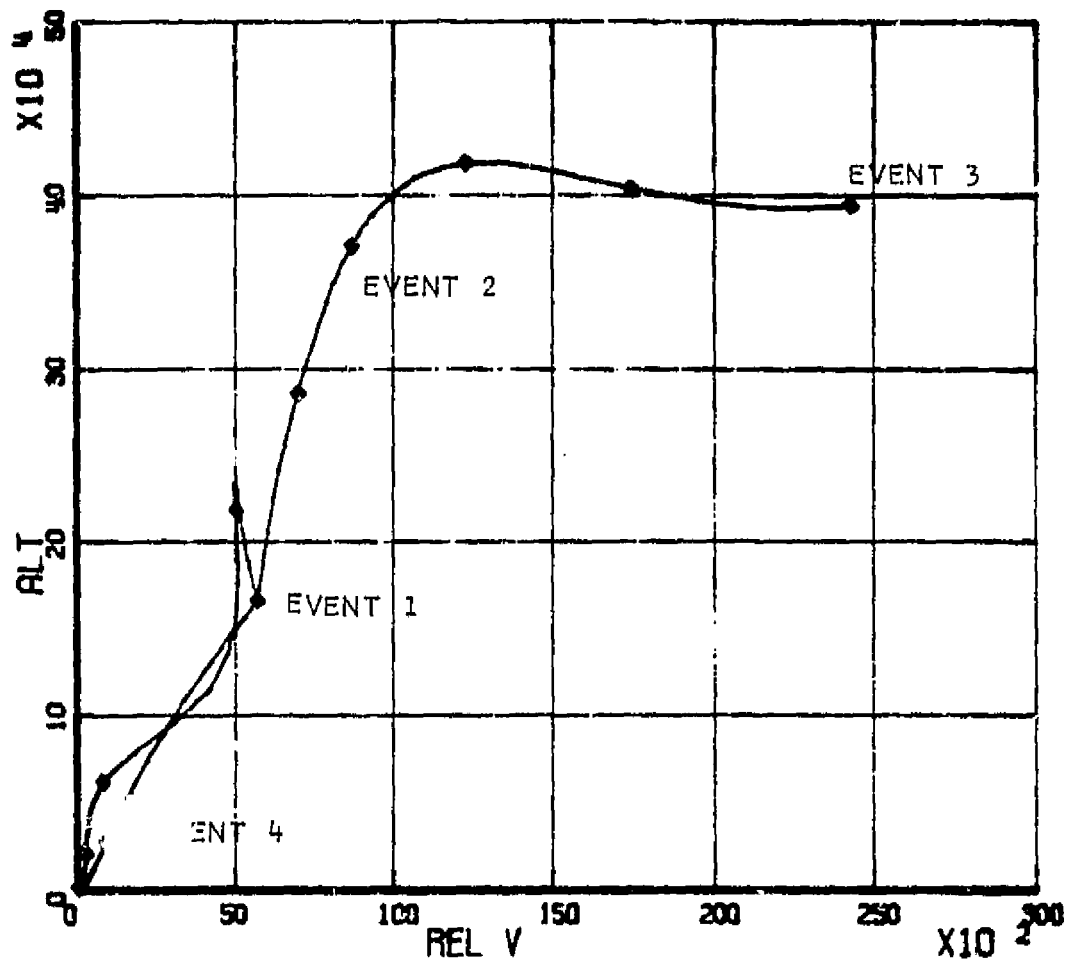
EDIN0503 FLT CONSTRAINTS DEC 75



EDIN0503 FLIGHT ATTITUDE DEC 75



EDIN0503 H-V PROFILE 16 DEC 75



SIGMA CORPORATION

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EDIN0504 DESIGN

SIMULATION RESULTS

FORECASTER: EDIN DESIGN CENTER DATE: 19 NOV 75
AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC TIME: 08:11
STUDY NO: EDIN0504

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 5.09 HIGH
PRESSURE ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR
REPLACEMENT OF THE SOLID ROCKET BOOSTERS.

MISSION: 140000.0 LB PAYLOAD
DUE EAST LAUNCH FROM ETP
A 250 FPS DMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL
MILE REFERENCE ORBIT.
A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED EXO-ATMOSPHERIC PITCH
PROFILE AND INITIAL TILT RATE.
MID POINT CONSTRAINT = SHUTTLE MISSION 1 RTLS/ROA
END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
ATMOSPHERIC INFIGHT CONSTRAINTS CONTROLLED BY HIGH
PRESSURE ENGINE THROTTLING AND/OR SSME THROTTLING.
MAX DYNAMIC PRESSURE = 650.0 PSF
MAX ACCELERATION = 3.0 G

PROPULSION: LRB: 5.09 HIGH PRESSURE ENGINES RATED AS FOLLOWS:

THRUST(SL) = 800000.00 LBS
THRUST(VAC) = 856800.00 LBS
THROTTLE = 1.00 TO .500
ISP(SL) = 327.60 SEC.
ISP(VAC) = 350.80 SEC.
FLOWRATE = 2442.2 LB/SEC
EXIT AREA = 32.000 SQ FT
MIX RATIO = 2.90:1

ORBITER: THREE SSME ENGINES RATED AS FOLLOWS:

THRUST(SL) = 375000.00 LBS
THRUST(VAC) = 470000.00 LBS
THROTTLE = 1.09 TO .500
ISP(SL) = 363.20 SEC
ISP(VAC) = 455.20 SEC
FLOWRATE = 1032.5 LB/SEC
EXIT AREA = 44.896 SQ FT
MIX RATIO = 6.00:1

AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION
WERE OBTAINED FROM SHUTTLE AERO ESTIMATES. ADJUSTMENTS
WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
REF AREA = 2557.0 SQ FT

STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS
ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND
INCREASED UP PAYLOADS.

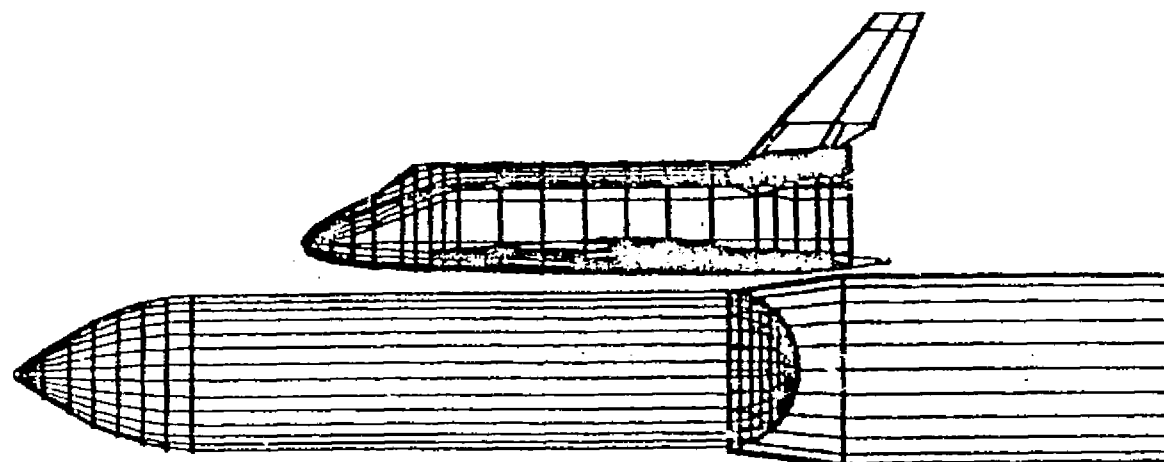
MASS PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC
ASSUMPTIONS.

LRB: WERS BASED ON SATURN TECHNOLOGY.
ET: FIXED MASS FRACTION DISTRIBUTED IN
ACCORDANCE WITH SHUTTLE ET WEIGHT
STATEMENT.

ORBITER: FEB 1975 SHUTTLE WITH MODS FOR
INCREASED UP PAYLOAD.

EDIN0504 DESIGN SIMULATION RESULTS

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                                WEIGHTS SUMMARY REPORT
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GLOW                                4261415.81
.
ET LIFT-OFF WEIGHT                    1878989.12
.
    ET INERT WEIGHT                    102458.0
    ET PROPELLANT                     1776561.56
.
LRB LIFT-OFF WEIGHT                    2055172.86
.
    LRB INERT WEIGHT                    200441.21
    LRB PROPELLANT                     1854731.67
.
ORBITER LIFT-OFF WEIGHT                327254.00
.
    ORBITER INERT WEIGHT                187254.00
    PAYLOAD                            140000.00
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ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	2862.	
BODY GROUP	43291.	
INDUCED ENVIRN PROTECT	19874.	
LANDING & AUX SYSTEMS	7683.	
PROPULSION-ASCENT	28054.	
PROPULSION-RCS	2657.	
PROPULSION-QMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2739.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 100K PAYLD	390.	
ORBITER EMPTY WEIGHT		151715.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	5024.	
PROPELLANT-RCS	6241.	
PROPELLANT-QMS	16149.	
ORBITER INERT WEIGHT		187254.
PAYLOAD		140000.
ORBITER PRELAUNCH WEIGHT		327254.

EXTERNAL TANK WEIGHT STATEMENT:

LOX TANK		16917.
BHD	82.	
FWD FRAME	53.	
FWD OGIVE	1396.	
AFT OGIVE	4694.	
XT 745 FRAME	326.	
BARREL	3035.	
INTERTANK FRAME	1107.	
AFT DOME	3809.	
SLOSH BAFFLES	2615.	
INTERTANK		13222.
MACHINED BARREL PNLS	5294.	
SK/STGR BARREL PNLS	5722.	
STABILIZING FRAMES(4)	1566.	
SRB THRST XT 985 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	71.	
BARREL PNLS SPLICES (8)	117.	
FRAME STABLIZERS	254.	
ET ASSY FASTENERS	198.	

LH2 TANK		41502.
FWD DOME	1979.	
XT 1129.9 FRAME	1953.	
BARREL NO.4	6789.	
XT 1377 FRAME	681.	
BARREL NO.3	6825.	
XT 1624 FRAME	681.	
BARREL NO.2	6829.	
XT 1871 FRAME	2139.	
BARREL NO.1	7223.	
XT 2058 FRAME	4088.	
AFT DOME	2315.	
THERMAL PROTECTION		8042.
LOX TANK	1724.	
INTERTANK	1790.	
LH2 TANK	4200.	
PROP (MECH+ELEC)	327.	
PROPULSION AND MECHANICAL SYSTEMS		4686.
LOX FEED SYS	2004.	
LOX ANTIGEYER SYS	188.	
LOX VENT SYS	106.	
LOX PRESS. SYS	228.	
LH2 FEED SYS	573.	
LH2 RECIR. SYS	37.	
LH2 VENT SYS	160.	
LH2 PRESS. SYS	169.	
HELIUM INJ. SYS	26.	
INTERTANK PURGE SYS	99.	
HAZARD GAS DETECTION SYS	10.	
FAIRINGS AND CONDUIT	424.	
LINE SUPTS. AND ATTACHS.	663.	
ELECTRICAL SYSTEM		290.
ET WIRING ASSY	196.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	18.	
CABLING ATTACHS.+SENSOR SUPTS.	76.	
ORB/SRB ATTACHMENTS		5574.
ORBITER SUPPORTS	3326.	
UMBILICAL BEAM	784.	
ORB/ET ATTACH FTGS	291.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL HDWR	673.	
MANUFACTURING VARIATION WT.		527.
EMPTY WEIGHT		90759.
UNUSABLE FLUIDS		506.
LH2 IN TANK	285.	
LH2 IN LINE	58.	
LOX IN LINE	163.	
PRE-PRESS.+INFLIGHT GASES		4583.
GH2	1191.	
GOX	3353.	
HELIUM	39.	
SEPARATION HARDWARE		6.
SRB SUPPORTS	0.	
ORB FITTINGS	6.	
FLT PERF RES		6603.
ET INERT WT		102458.
MAIN PROPELLANTS		1776531.
LOX	1522741.	
LH2	253790.	
ET LIFT-OFF WEIGHT		1878989.
MASS FRACTION		.9490

LIQUID ROCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		83633.
INTEGRAL LOX TANK	16395.	
INTEGRAL FUEL TANK	8715.	
INTERSTAGE	8583.	
AFT SKIRT	16159.	
THRUST STRUCTURE	33780.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		1998.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1058.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		677.
ELECTRICAL SYSTEM	580.	
CONTROL SYSTEM	97.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		58188.
ENGINES (DRY)	32305.	
ACCESSORIES	706.	
GIMBAL SYSTEM	8959.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	4822.	
OXIDIZER SYSTEM	7040.	
SEPARATION AND RECOVERY SYSTEM		14755.
SEPARATION SYSTEM	2488.	
CHUTE SYS (MAIN AND DROGUE)	4549.	
FLOTATION SYSTEM	82.	
RECOVERY AIDS	81.	
FITTINGS AND SUPPORTS	157.	
RETRD SYS (100 F/S DEL V)	2522.	
REENTRY HEAT SHIELD	4876.	
STAGE DRY WEIGHT		167688.
CONTINGENCY		0.
EMPTY WEIGHT		167688.
PROPELLANT RESIDUALS		29693.
FUEL BIAS	1800.	
TRAPPED LOX TANK GASES	3069.	
TRAPPED FUEL TANK GASES	2138.	
FROST TRAPPED	315.	
TRAPPED FUEL	8042.	
TRAPPED LOX	14329.	
IN-FLIGHT LOSSES		3060.
FUEL LOSSES	1293.	
LOX LOSSES	1767.	
MAIN PROPELLANTS		1854732.
FUEL	475572.	
LOX	1379159.	
BLOW		2055173.
MASS FRACTION (BASED ON INERT WT)		.9025

ORBITER WT	327254.0
ET WEIGHT	1878989.1
LRB STAGE WT	2055172.9
GLOW	4261415.9
EFFECTIVE STG 1 LAMBDA	.92183
EFFECTIVE STG 2 LAMBDA	.92522

CONVERGENCE DATA:

GLDM	4241412.	
DROP WEIGHT		102453.
PAYLOAD		140200.
TOTAL VIDEAL	30230.7	
STAGE 1 VIDEAL		10116.3
STAGE 2 VIDEAL		20114.4
TOTAL PROPELLANT	3431035.	
LFE PROPELLANT		1654583.
BT PROPELLANT		1776562.

STAGE 1 LIFTING DATA

AVERAGE SP. IMP.	133.76
LIFT-OFF TIME	1.315
MAXIMUM Q	649.9
TIME AT MAX Q	30.0
ITG : MAX LF	2.00
TIME AT MAX LF	142.0
EFF WDOT LFE	12304.4
EFF WDOT EVENT 1	15680.7

STAGING CONDITIONS:

WEIGHT	1898021.
REL VELOCITY (FPS)	5920.9
REL F.P. ANGLE (DEG)	24.26
ALTITUDE (FT)	172523.
TIME (SECS)	150.72
ATT AFTER ITG (DEG)	1.32

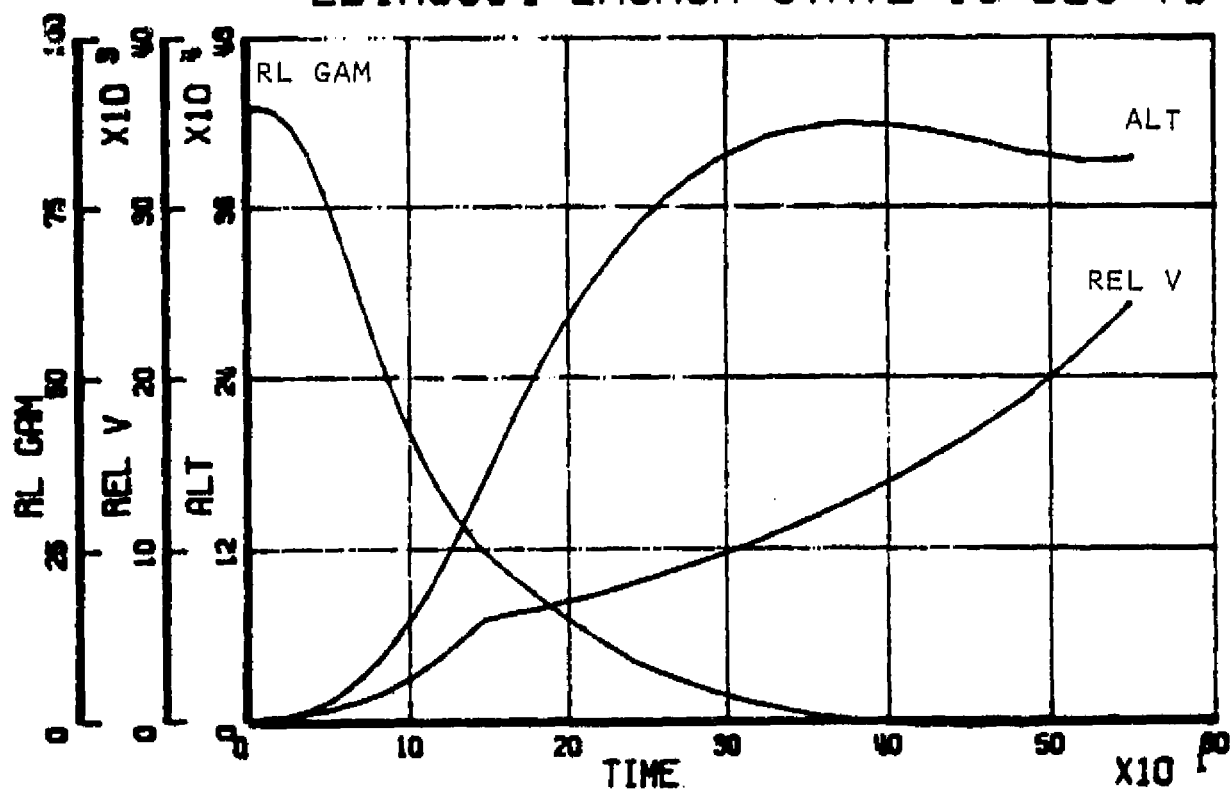
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MISSION SUMMARY: NOVEMBER 19, 1975

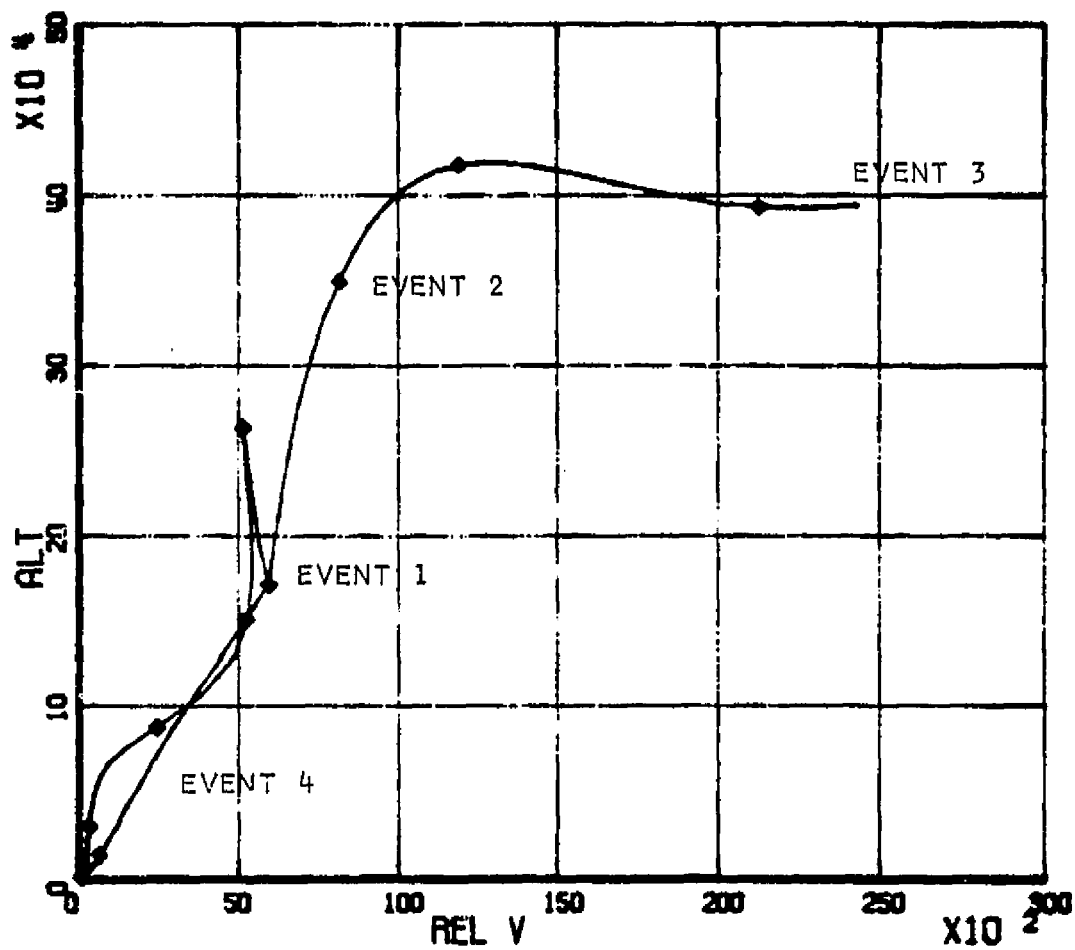
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4
TIME (SECS)	150.7	246.9	351.9	580.6
ALTITUDE (K FT)	172.5	348.3	394.2	0
REL VELOCITY (100 FPS)	59.2	21.4	243.0	1.86
REL GAMMA (DEG)	24.7	8.27	.528	-89.8
WEIGHT (K LBS)	4261.4	1697.6	1373.0	200.4
WEIGHT DROP (K LBS)	200.4	0	102.6	0
THROW HEIGHT (K LBS)	1697.6	1373.0	127.45	0
CUM VIDEAL (100 FPS)	101.2	132.2	302.2	0
DOWNRANGE (NM)	38.38	156.0	960.3	223.4

EVENT 1	SECO SEPARATION	EVENT 3	HELD INJECTION
EVENT 2	RTG ADR CONSTRAINT	EVENT 4	LFE TOUCHDOWN

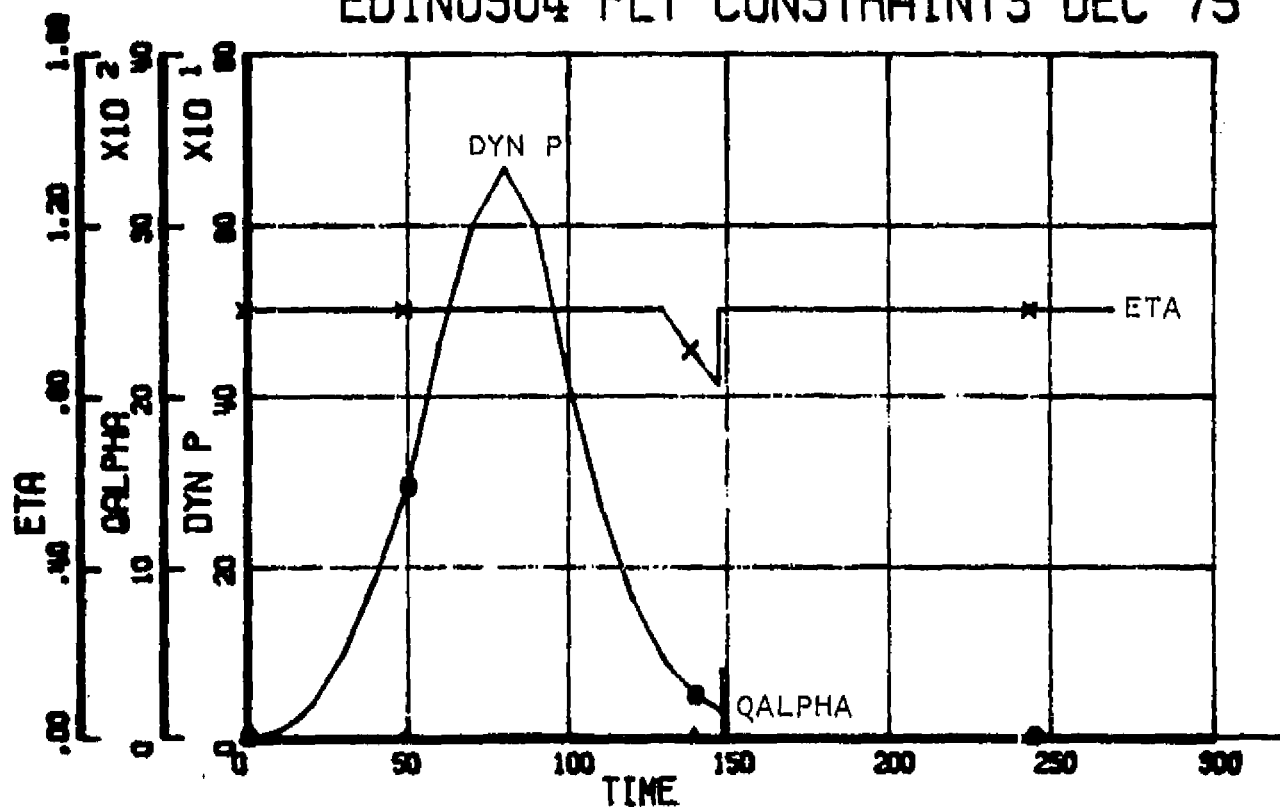
EDIN0504 LAUNCH STATE 16 DEC 75



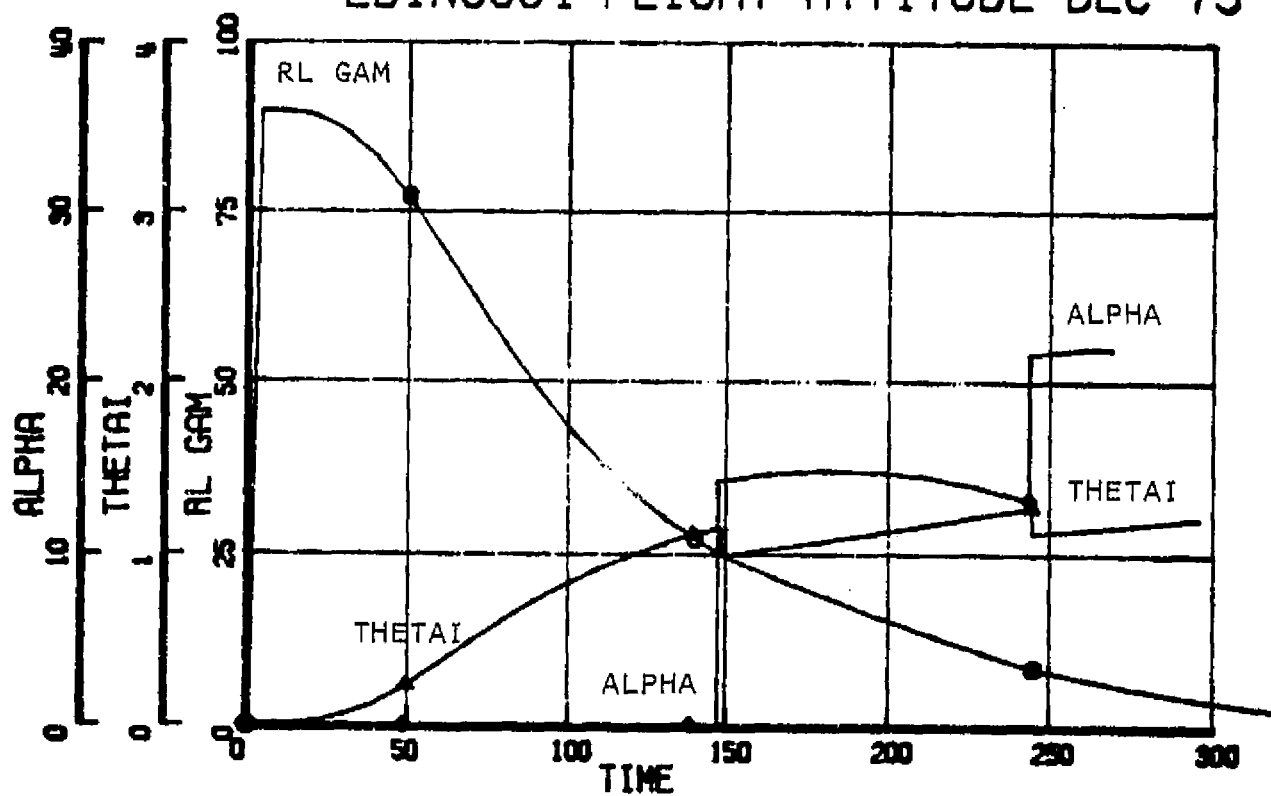
EDIN0504 H-V PROFILE 16 DEC 75



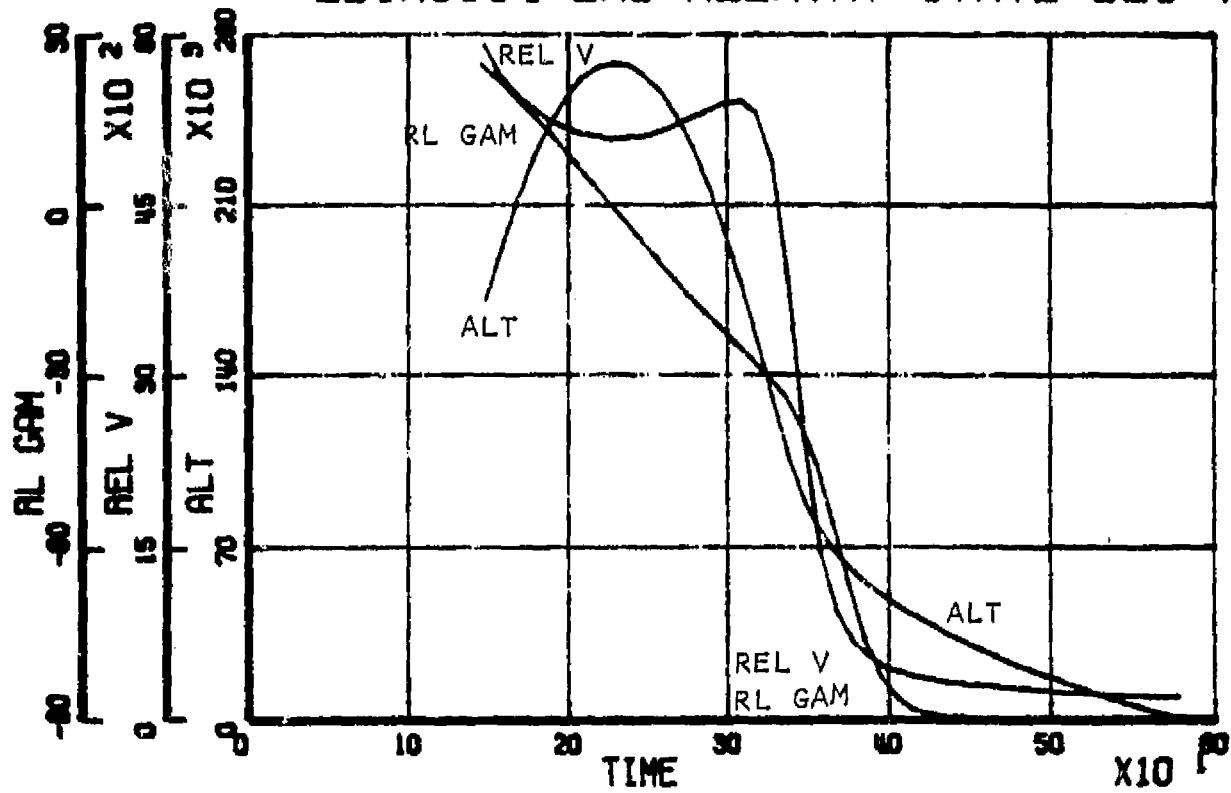
EDIN0504 FLT CONSTRAINTS DEC 75



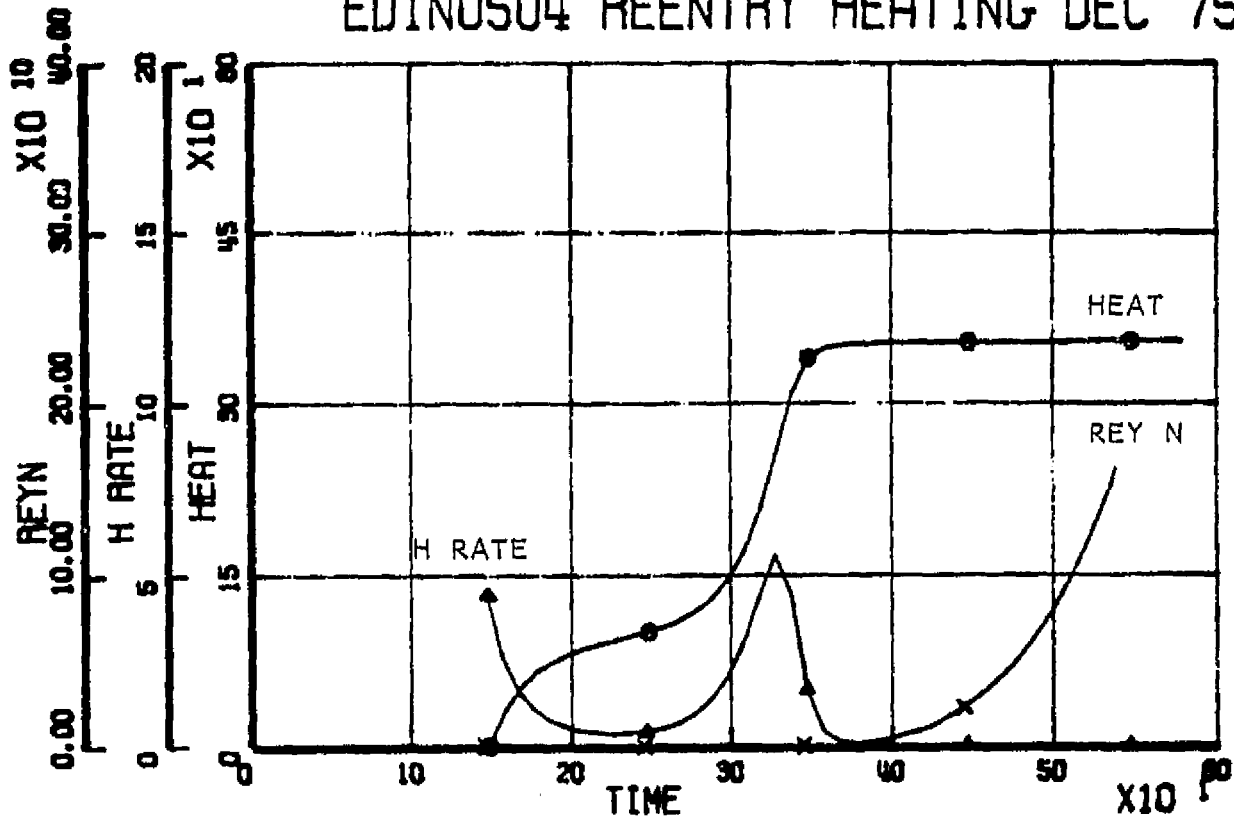
EDIN0504 FLIGHT ATTITUDE DEC 75



EDIN0504 LRB REENTRY STATE DEC 75



EDIN0504 REENTRY HEATING DEC 75



EDIN0504A DESIGN
SIMULATION RESULTS

 FORECASTER: EDIN DESIGN CENTER DATE: 8 DEC 75
 AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC TIME: 12:45
 STUDY NO: EDIN0504

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 6.61 HIGH PRESSURE ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR REPLACEMENT OF THE SOLID ROCKET BOOSTERS.

MISSION: 150000.0 LB PAYLOAD
 DUE EAST LAUNCH FROM ETB
 A 250 FPS QMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL MILE REFERENCE ORBIT.
 A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED EXO-ATMOSPHERIC PITCH PROFILE AND INITIAL TILT RATE.
 MID POINT CONSTRAINT = SHUTTLE MISSION 1 RTLC+ROB
 END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
 ATMOSPHERIC INFIGHT CONSTRAINTS CONTROLLED BY HIGH PRESSURE ENGINE THROTTLING AND/OR RCS THROTTLING.
 MAX DYNAMIC PRESSURE = 250.0 PSF
 MAX ACCELERATION = 3.0 G

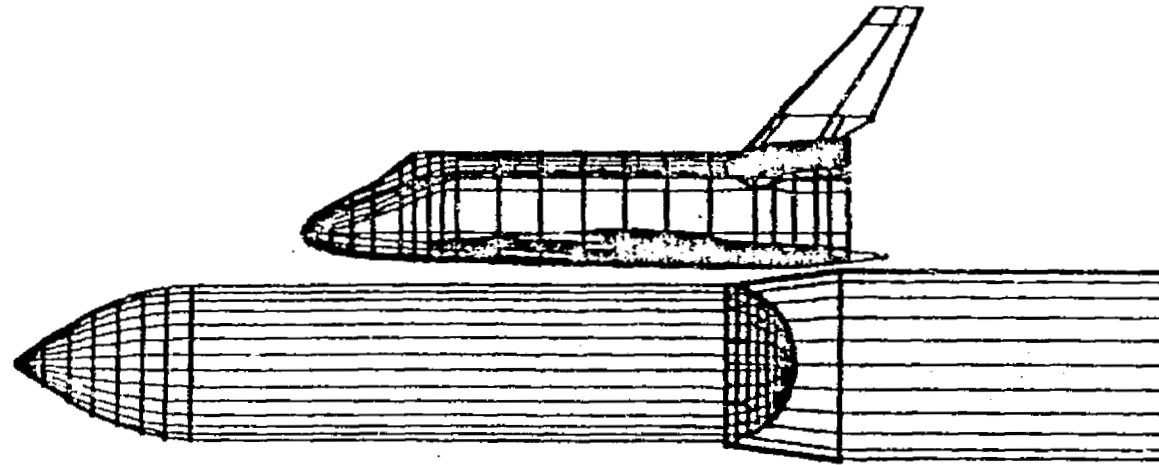
PROPULSION: LRB: 6.61 HIGH PRESSURE ENGINES RATED AS FOLLOWS:
 THRUST(SL) = 800000.00 LBS
 THRUST(VAC) = 866293.00 LBS
 THROTTLE = 1.00 TO .500
 ISP(SL) = 321.00 SEC.
 ISP(VAC) = 347.60 SEC.
 FLOWRATE = 2492.2 LB/SEC
 EXIT AREA = 32.000 SQ FT
 MIX RATIO = 2.50:1
 ORBITER: THREE RCS ENGINES RATED AS FOLLOWS:
 THRUST(SL) = 375000.00 LBS
 THRUST(VAC) = 470000.00 LBS
 THROTTLE = 1.00 TO .500
 ISP(SL) = 363.20 SEC
 ISP(VAC) = 455.20 SEC
 FLOWRATE = 1032.5 LB/SEC
 EXIT AREA = 44.896 SQ FT
 MIX RATIO = 6.00:1

AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION WERE OBTAINED FROM SHUTTLE AERO ESTIMATES. ADJUSTMENTS WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
 REF AREA = 2557.6 SQ FT

STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND INCREASED UP PAYLOADS.

MASS PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC ASSUMPTIONS.
 LRB: WERE BASED ON SATURN TECHNOLOGY.
 ET: FIXED MASS FRACTION DISTRIBUTED IN ACCORDANCE WITH SHUTTLE ET WEIGHT STATEMENT.
 ORBITER: FEB 1975 SHUTTLE WITH MODS FOR INCREASED UP PAYLOAD.

EDIN0504A DESIGN SIMULATION RESULTS



WEIGHTS SUMMARY REPORT

GLW		4804473.56
ET LIFT-OFF WEIGHT		1904993.36
ET INERT WEIGHT	103931.98	
ET PROPELLANT	1801061.42	
LRB LIFT-OFF WEIGHT		2561666.34
LRB INERT WEIGHT	228415.21	
LRB PROPELLANT	2333251.19	
ORBITER LIFT-OFF WEIGHT		337814.00
ORBITER INERT WEIGHT	187814.00	
PAYLOAD	150000.00	

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	2862.	
BODY GROUP	43291.	
INDUCED ENVIRON PROTECT	19874.	
LANDING & AUX SYSTEMS	7883.	
PROPULSION-ASCENT	28054.	
PROPULSION-POS	2657.	
PROPULSION-OMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	3739.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1287.	
WT PENALTY FOR 150K PAYLD	950.	
ORBITER EMPTY WEIGHT		152275.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	5084.	
PROPELLANT-POS	6241.	
PROPELLANT-OMS	16149.	
ORBITER INERT WEIGHT		187814.
PAYLOAD		150000.
ORBITER PRELAUNCH WEIGHT		337814.

EXTERNAL TANK WEIGHT STATEMENT:

LOX TANK		17151.
BHD	34.	
FWD FRAME	54.	
FWD OGIVE	1415.	
AFT OGIVE	4758.	
XT 245 FRAME	330.	
BARREL	3077.	
INTERTANK FRAME	1123.	
AFT DOME	3659.	
SLOSH BAFFLES	2651.	
INTERTANK		13404.
MACHINED BARREL PNLS	5367.	
SK/STGR BARREL PNLS	5801.	
STABILIZING FRAMES(4)	1587.	
SRB THRST XT 985 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	72.	
BARREL PNLS SPLICES (8)*	119.	
FRAME STABLIZERS	257.	
ET ASSY FASTENERS	201.	

LH2 TANK		42075.
FWD DOME	2006.	
XT 1129.9 FRAME	1960.	
BARREL NO.4	6262.	
XT 1377 FRAME	691.	
BARREL NO.3	6919.	
XT 1624 FRAME	691.	
BARREL NO.2	6923.	
XT 1871 FRAME	2168.	
BARREL NO.1	7322.	
XT 2058 FRAME	4145.	
AFT DOME	2347.	
THERMAL PROTECTION		8153.
LOX TANK	1748.	
INTER-TANK	1815.	
LH2 TANK	4258.	
PROP (MECH+ELEC)	332.	
PROPULSION AND MECHANICAL SYSTEMS		4750.
LOX FEED SYS	2031.	
LOX ANTIGEEZER SYS	191.	
LOX VENT SYS	107.	
LOX PRESS. SYS	231.	
LH2 FEED SYS	531.	
LH2 RECIP. SYS	38.	
LH2 VENT SYS	162.	
LH2 PRESS. SYS	171.	
HELIUM INJ. SYS	26.	
INTER-TANK PURGE SYS	101.	
HAZARD GAS DETECTION SYS	10.	
FAIRINGS AND CONDUIT	429.	
LINE SUPTS. AND ATTACHS.	672.	
ELECTRICAL SYSTEM		294.
ET WIRING ASSY	198.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	18.	
CABLING ATTACHS.+SENSOR SUPTS.	77.	
ORB/SRB ATTACHMENTS		5651.
ORBITER SUPPORTS	3878.	
UMBILICAL BEAM	795.	
ORB/ET ATTACH FTGS	295.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL ADMR	623.	
MANUFACTURING VARIATION WT.		534.
EMPTY WEIGHT		92012.
UNUSABLE FLUIDS		513.
LH2 IN TANK	298.	
LH2 IN LINE	59.	
LOX IN LINE	166.	
PRE-PRESS.+INFLIGHT GASES		4647.
GH2	1206.	
GOX	3400.	
HELIUM	39.	
SEPARATION HARDWARE		6.
SRB SUPPORTS	0.	
ORB FITTINGS	6.	
FLT PERF RES		6754.
ET INERT WT		103932.
MAIN PROPELLANTS		1801061.
LOX	1543767.	
LH2	257294.	
ET LIFT-OFF WEIGHT		1904993.
MASS FRACTION (BASED ON INERT WEIGHT)		.94544

LIQUID POCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		93476.
INTEGRAL LOX TANK	19812.	
INTEGRAL FUEL TANK	12203.	
INTERSTAGE	8583.	
AFT SKIRT	16159.	
THRUST STRUCTURE	36716.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		2136.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1195.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		766.
ELECTRICAL SYSTEM	655.	
CONTROL SYSTEM	110.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		66517.
ENGINES (DRY)	41988.	
ACCESSORIES	306.	
GIMBAL SYSTEM	3884.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	6668.	
OXIDIZER SYSTEM	9715.	
SEPARATION AND RECOVERY SYSTEM		15644.
SEPARATION SYSTEM	2468.	
CHUTE SYS (MAIN AND DROGUE)	5096.	
FLOTATION SYSTEM	92.	
RECOVERY AIDS	91.	
FITTINGS AND SUPPORTS	175.	
RETRO SYS (100 F/S DEL V)	2825.	
REENTRY HEAT SHIELD	4976.	
STAGE DRY WEIGHT		186975.
CONTINGENCY		0.
EMPTY WEIGHT		186975.
PROPELLANT RESIDUALS		37492.
FUEL BIAS	1800.	
TRAPPED LOX TANK GASES	3709.	
TRAPPED FUEL TANK GASES	2994.	
FROST TRAPPED	401.	
TRAPPED FUEL	11273.	
TRAPPED LOX	17316.	
IN-FLIGHT LOSSES		3948.
FUEL LOSSES	1813.	
LOX LOSSES	2135.	
LRB INERT WT		226415.
MAIN PROPELLANTS		2333251.
FUEL	666643.	
LOX	1666608.	
BLOW		2561666.
MASS FRACTION (BASED ON INERT WT)		.91083

ORBITER WT	337814.0
ET WEIGHT	1904993.4
LRB WEIGHT	2561666.3
GLOW	4804473.7
STG 1 LAMBDA	.92500
STG 2 LAMBDA	.92686

CONVERGENCE DATA:

GLOW	4804474.	
TARGET PAYLOAD	150000.	
ACTUAL PAYLOAD		150224.
TOTAL VIDEAL	30065.0	
STAGE 1 VIDEAL		9637.1
STAGE 2 VIDEAL		20627.9
TOTAL PROPELLANT	4134089.	
LPB PROPELLANT		2333217.
ET PROPELLANT		1800871.
STAGE JETTISON WEIGHTS		
STAGE 1 JETTISON WT		222415.
STAGE 2 JETTISON WT		103932.

STAGE 1 SIZING DATA

AVERAGE SP. IMP.	346.33
LIFT-OFF T/M	1.350
MAXIMUM Q	649.5
TIME AT MAX Q	72.8
STG 1 MAX LF	3.00
TIME AT MAX LF	134.0
EFF WDOT/LPB	16274.6
EFF WDOT/EVENT 1	19650.8

STAGING CONDITIONS:

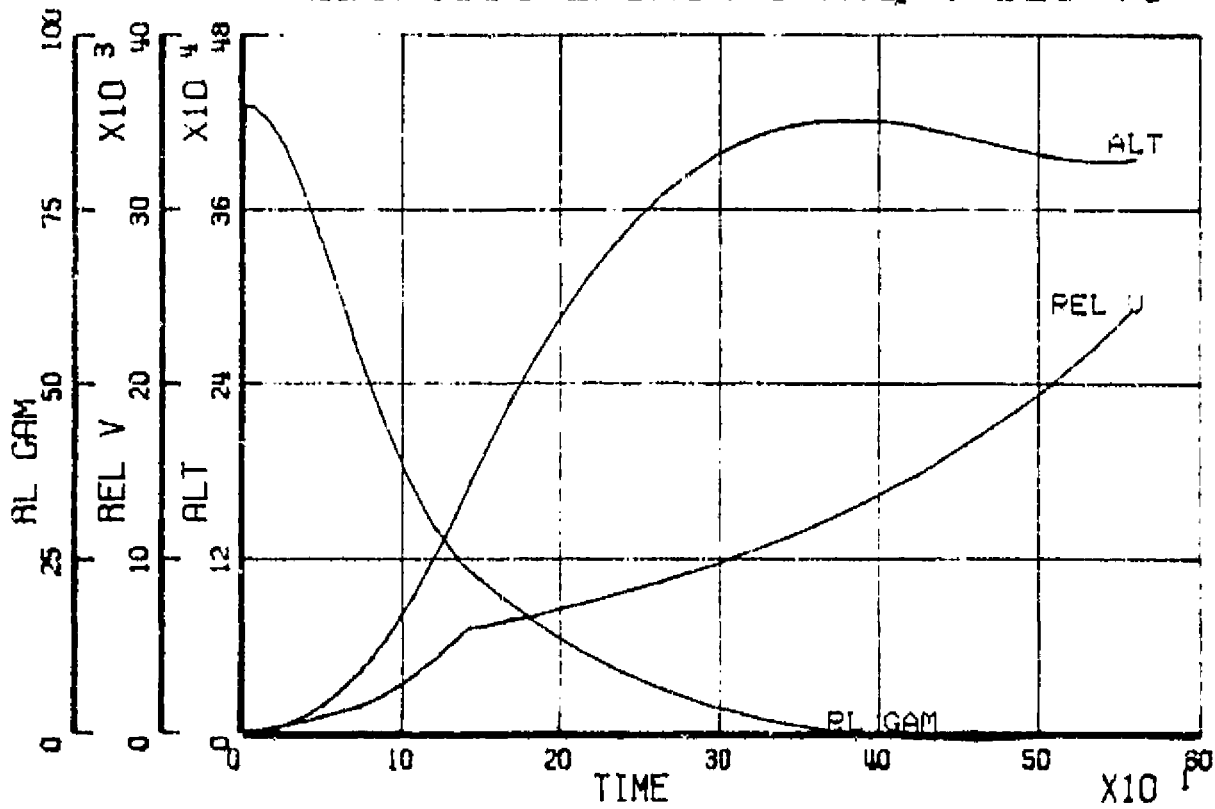
WEIGHT	1987214.
REL VELOCITY (FPS)	5948.6
REL F.P. ANGLE (DEG)	23.70
ALTITUDE (FT)	171048.
TIME (SEC)	143.37
ATT AFTER STG (DEG)	.97

MISSION SUMMARY: DECEMBER 6, 1975

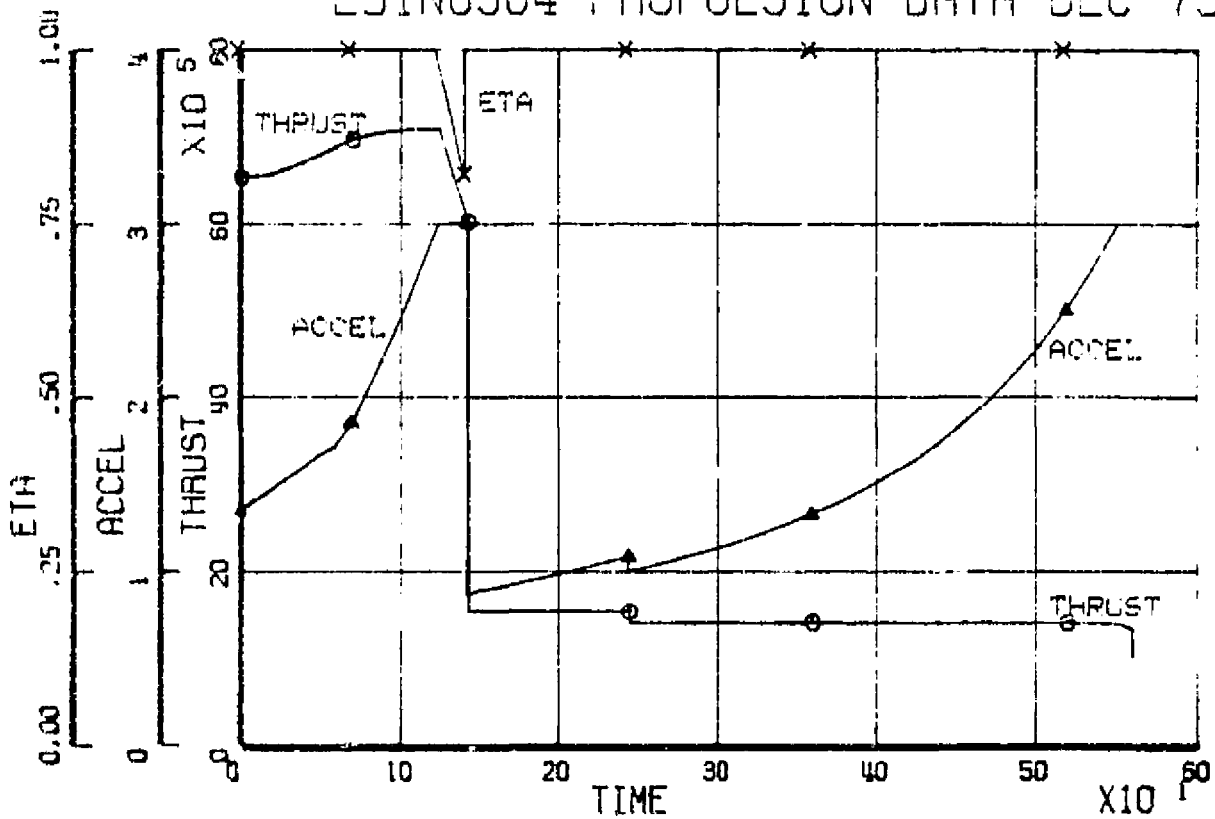
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4
TIME (SEC)	143.4	244.1	559.7	552.5
ALTITUDE (K FT)	171.0	348.6	354.3	0
REL VELOCITY (100 FPS)	59.5	81.4	243.0	1.988
REL GAMMA (DEG)	23.7	8.28	.528	-89.8
WEIGHT (K LBS)	4804.5	1758.8	1418.6	228.4
WEIGHT DROP (K LBS)	205.4	0	103.9	0
THROW WEIGHT (K LBS)	1758.8	1418.6	338.04	0
CUM VIDEAL (100 FPS)	98.37	129.8	300.7	0
DOWNRANGE (NM)	39.1	163.3	993.0	223.0

EVENT 1	RECO/SEPARATION	EVENT 3	MECO INJECTION
EVENT 2	ATLS/ROA CONSTRAINT	EVENT 4	LPB TOUCHDOWN

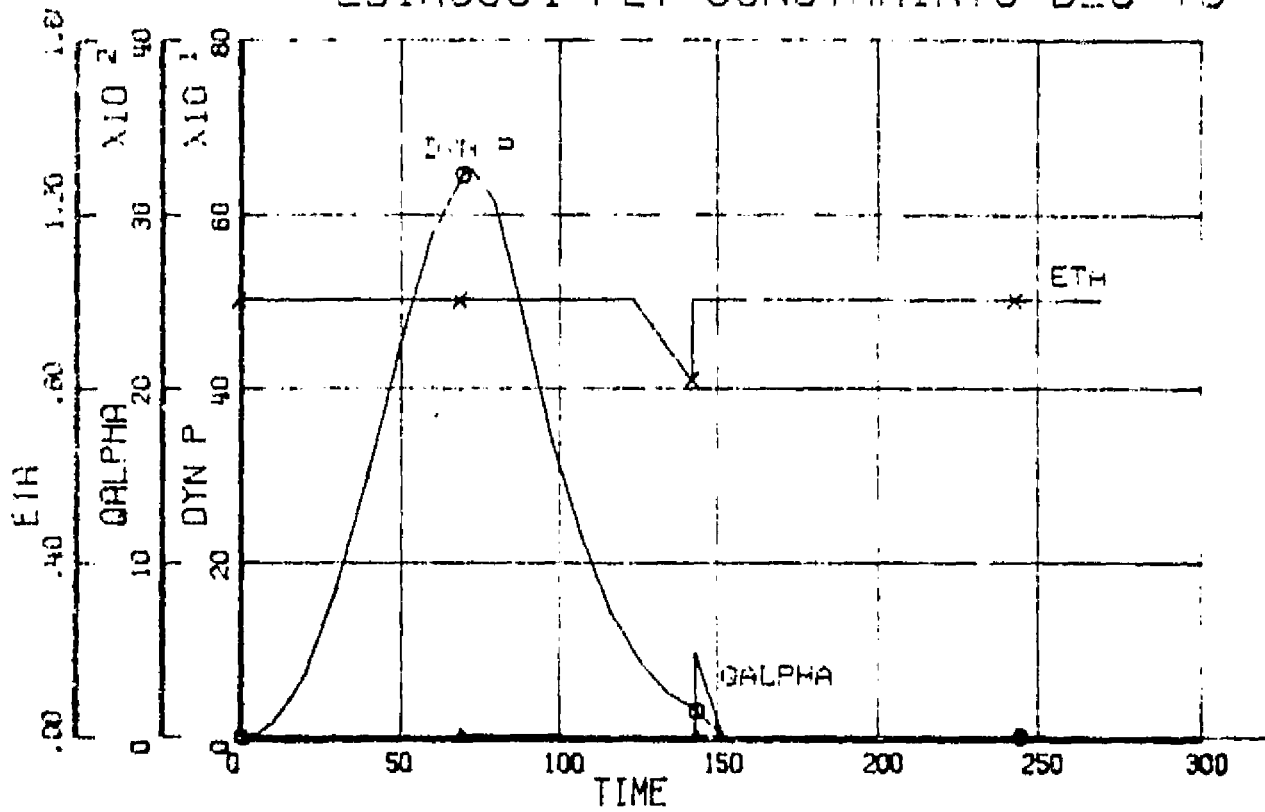
EDIN0504 LAUNCH STATE, 5 DEC 75



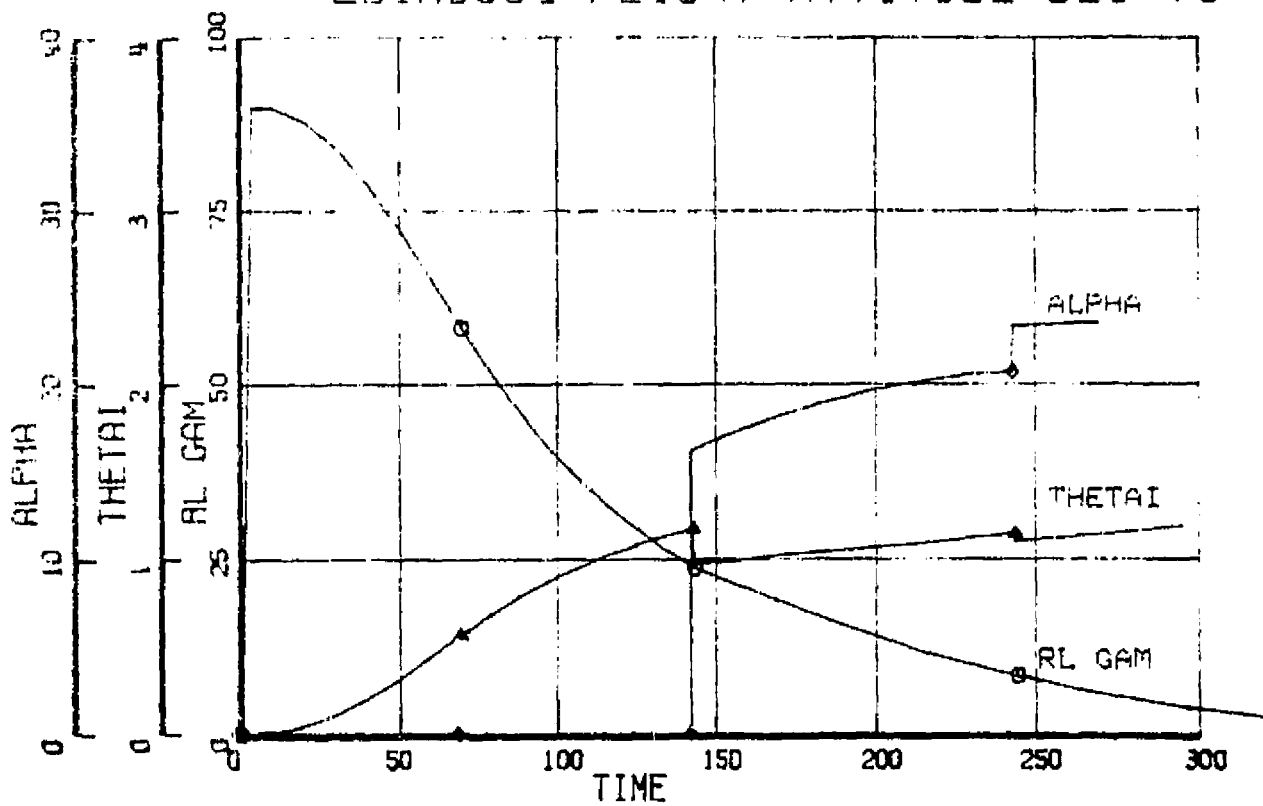
EDIN0504 PROPULSION DATA DEC 75



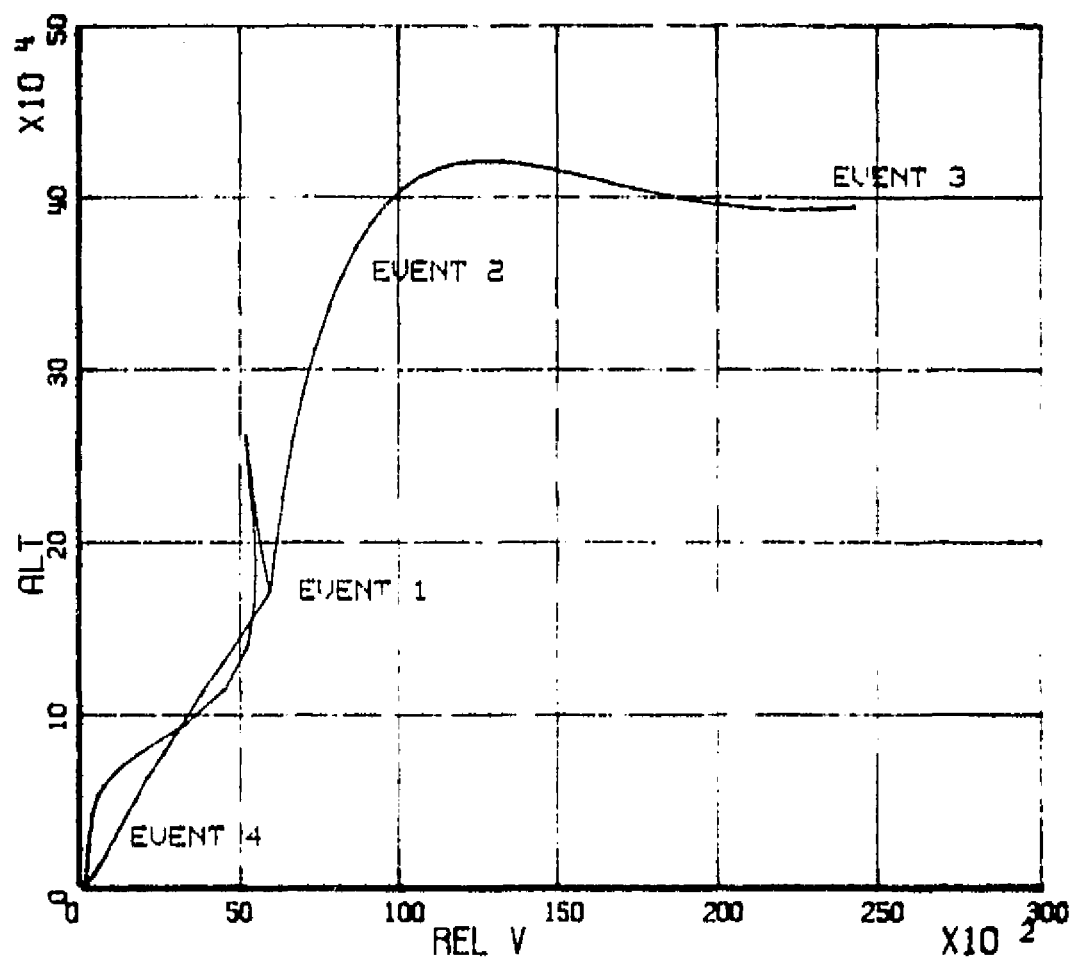
EDIN0504 FLT CONSTRAINTS DEC 75



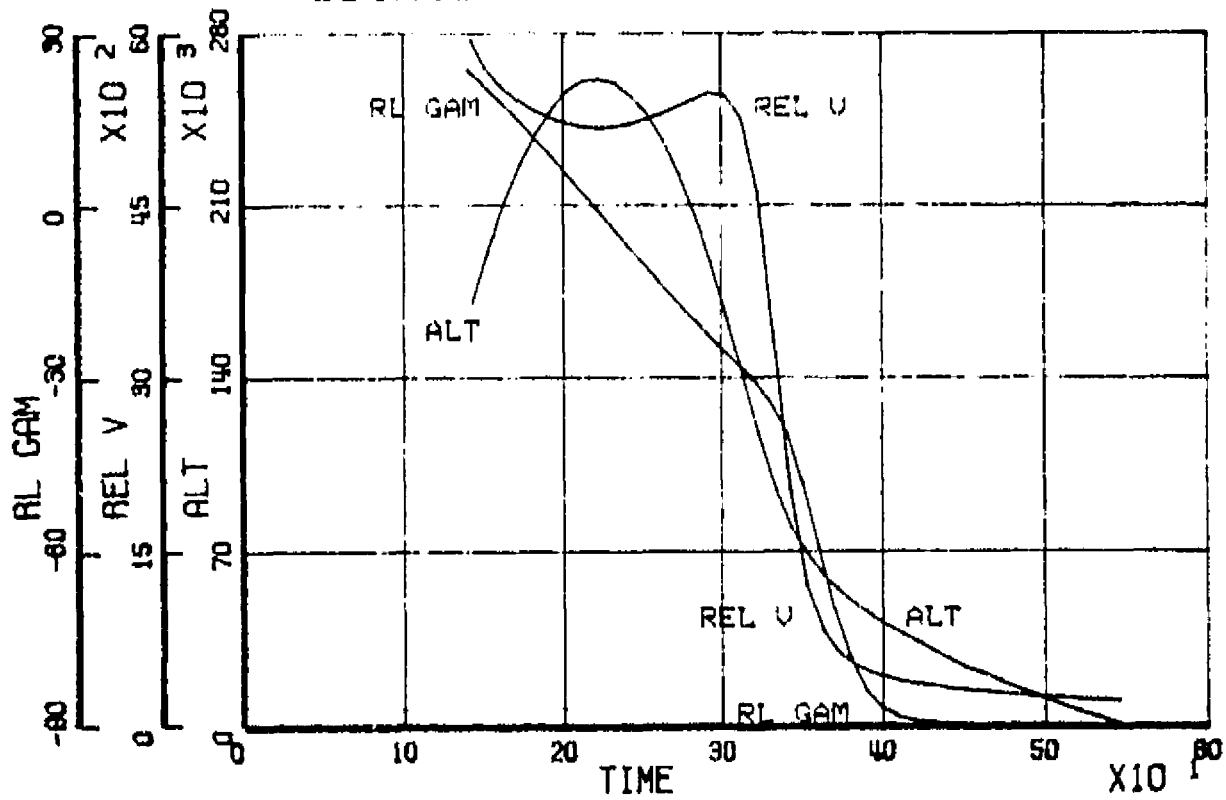
EDIN0504 FLIGHT ATTITUDE DEC 75



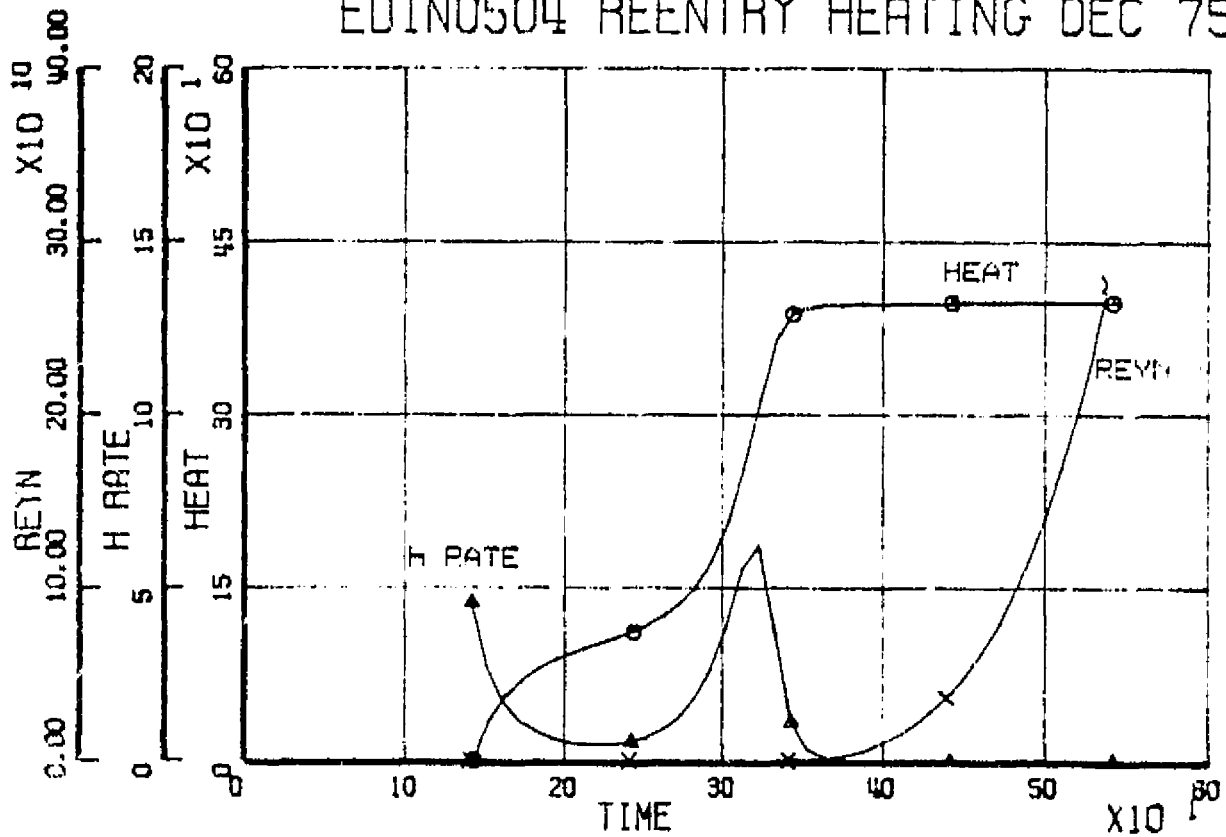
EDIN0504 H-V PROFILE 6 DEC 75



EDIN0504 LRB REENTRY STATE DEC 75



EDIN0504 REENTRY HEATING DEC 75



EDIN0504B DESIGN
SIMULATION RESULTS

 FORECASTER: EDIN DESIGN CENTER DATE: 9 DEC 75
 AFFILIATION: ENGINEERING ANALYTIC DIVISION-JSC TIME: 15:08
 STUDY NO: EDINCSD4

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 3,000 F-1
 ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR REPLACEMENT
 OF THE SOLID ROCKET BOOSTERS.

MISSION: MAXIMUM PAYLOAD
 DUE EAST LAUNCH FROM ETP
 A 250 FPS DMC DELTA VEL IN EXCESS OF A 50X100 NAUTICAL
 MILE REFERENCE ORBIT.
 A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED EXO-ATMOSPHERIC PITCH
 PROFILE AND INITIAL TILT RATE.
 MID POINT CONSTRAINT = SHUTTLE MISSION 1 RTLI/ADR
 END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
 ATMOSPHERIC INFIGHT CONSTRAINTS CONTROLLED BY ONE F1
 ENGINE SHUTDOWN AND/OR GIME THROTTLING.
 MAX DYNAMIC PRESSURE = 250.0 PSF
 MAX ACCELERATION = 3.0 G

PROPULSION: LRB: 3,000 F-1 ENGINES RATED AS FOLLOWS:
 THRUST(SL) = 1606798.5 LBS
 THRUST(VAC) = 1748060.0 LBS
 ISP(SL) = 266.01 SEC.
 ISP(VAC) = 289.40 SEC.
 FLOWRATE = 6040.3 LB/SEC
 EXIT AREA = 66.763 SQ FT
 MIX RATIO = 2.27:1
 ORBITER: THREE GIME ENGINES RATED AS FOLLOWS:
 THRUST(SL) = 375000.00 LBS
 THRUST(VAC) = 420000.00 LBS
 THROTTLE = 1.09 TO .500
 ISP(SL) = 363.20 SEC
 ISP(VAC) = 455.20 SEC
 FLOWRATE = 1032.5 LB/SEC
 EXIT AREA = 44.896 SQ FT
 MIX RATIO = 6.00:1

AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION
 WERE OBTAINED FROM SHUTTLE AERO ESTIMATES. ADJUSTMENTS
 WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
 REF AREA = 2557.0 SQ FT

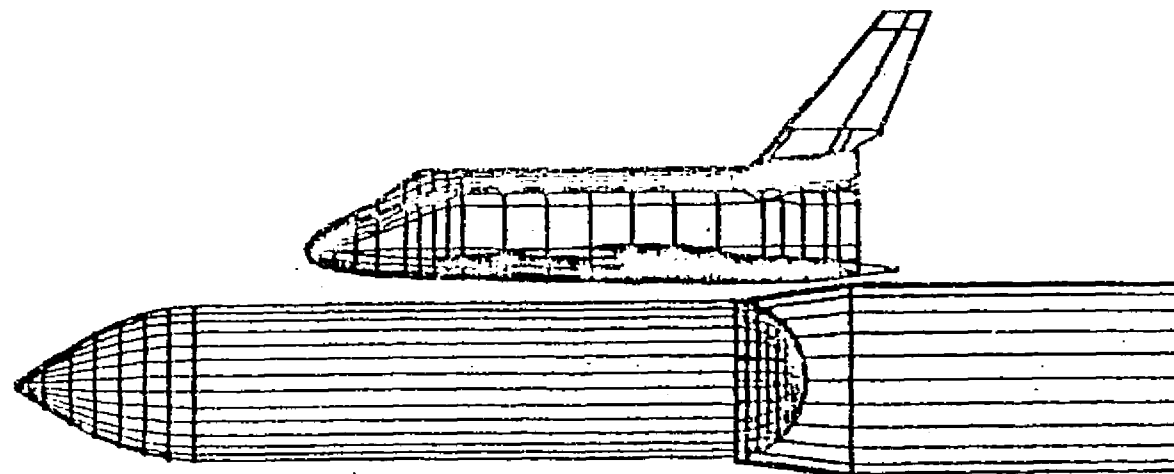
STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS
 ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND
 INCREASED UP PAYLOADS.

MASS PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC
 ASSUMPTIONS.

LRB: WERE BASED ON SATURN TECHNOLOGY.
 ET: FIXED MASS FRACTION DISTRIBUTED IN
 ACCORDANCE WITH SHUTTLE ET WEIGHT
 STATEMENT.
 ORBITER: FEB 1975 SHUTTLE WITH MODS FOR
 INCREASED UP PAYLOAD.

EDIN0504B DESIGN SIMULATION RESULTS

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WEIGHTS SUMMARY REPORT

GLOW	4598410.00
ET LIFT-OFF WEIGHT	1904993.30
ET INERT WEIGHT	103931.97
ET PROPELLANT	1801061.36
LRB LIFT-OFF WEIGHT	2427663.00
LRB INERT WEIGHT	247739.73
LRB PROPELLANT	2179323.00
ORBITER LIFT-OFF WEIGHT	265754.00
ORBITER INERT WEIGHT	187254.00
PAYLOAD	78500.000

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	3862.	
BODY GROUP	43291.	
INDUCED SWIRL PROTECT	19874.	
LANDING & RUM SYSTEMS	7683.	
PROPULSION-ASCENT	28054.	
PROPULSION-RCS	2657.	
PROPULSION-OMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2739.	
AVIONICS	5779.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 100K PAYLD	290.	
ORBITER EMPTY WEIGHT		151715.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	5024.	
PROPELLANT-RCS	6241.	
PROPELLANT-OMS	19149.	
ORBITER INERT WEIGHT		127254.
PAYLOAD		79500.
ORBITER PRELAUNCH WEIGHT		206754.

EXTERNAL TANK WEIGHT STATEMENT:

LOW TANK		17151.
BHD	84.	
FWD FRAME	54.	
FWD OSIVE	1415.	
AFT OSIVE	4758.	
WT 745 FRAME	330.	
BARREL	3077.	
INTERTANK FRAME	1123.	
AFT DOME	3659.	
SLOSH BAFFLES	2651.	
INTERTANK		13404.
MACHINED BARREL PNLS	5367.	
2K/STGR BARREL PNLS	5801.	
STABILIZING FRAMES(4)	1587.	
SRB THRST MT 985 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	72.	
BARREL PNLS SPLICES (8)	119.	
FRAME STABILIZERS	257.	
ST ADGY FASTENERS	201.	

LH2 TANK		42075.
FWD DOME	2006.	
XT 1129.9 FRAME	1920.	
BARREL NO.4	6832.	
XT 1377 FRAME	691.	
BARREL NO.3	6919.	
XT 1624 FRAME	691.	
BARREL NO.2	6923.	
XT 1871 FRAME	2168.	
BARREL NO.1	7322.	
XT 2058 FRAME	4145.	
AFT DOME	2347.	
THERMAL PROTECTION		8153.
LOX TANK	1748.	
INTERTANK	1315.	
LH2 TANK	4258.	
PROP (MECH+ELEC)	332.	
PROPULSION AND MECHANICAL SYSTEMS		4750.
LOX FEED SYS	2031.	
LOX ANTIGEEPER SYS	131.	
LOX VENT SYS	107.	
LOX PRESS. SYS	231.	
LH2 FEED SYS	531.	
LH2 RECIR. SYS	38.	
LH2 VENT SYS	162.	
LH2 PRESS. SYS	171.	
HELIUM INJ. SYS	26.	
INTERTANK PURGE SYS	101.	
HAZARD GAS DETECTION SYS	10.	
FAIRINGS AND CONDUIT	429.	
LINE SUPTS. AND ATTACHS.	672.	
ELECTRICAL SYSTEM		294.
ET WIRING ASSY	198.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	18.	
CABLING ATTACHS.+SENSOR SUPTS.	77.	
ORB/SRB ATTACHMENTS		5651.
ORBITER SUPPORTS	3878.	
UMBILICAL BEAM	795.	
ORB/ET ATTACH FTGS	295.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL HDWR	683.	
MANUFACTURING VARIATION WT.		534.
EMPTY WEIGHT		92012.
UNUSABLE FLUIDS		513.
LH2 IN TANK	238.	
LH2 IN LINE	59.	
LOX IN LINE	165.	
PRE-PRESS.+INFLIGHT GASES		4647.
GH2	1203.	
GDX	3400.	
HELIUM	39.	
SEPARATION HARDWARE		6.
SRB SUPPORTS	0.	
ORB FITTINGS	6.	
FLT PERF RES		6754.
ET INERT WT		103932.
MAIN PROPELLANTS		1301061.
LOX	1543767.	
LH2	257294.	
ET LIFT-OFF WEIGHT		1904993.
MASS FRACTION (BASED ON INERT WEIGHT)		.94544

LIQUID ROCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		83478.
INTEGRAL LOX TANK	19812.	
INTEGRAL FUEL TANK	13203.	
INTERSTAGE	8583.	
AFT SKIRT	12159.	
THRUSET STRUCTURE	36718.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLARE)	6916.	
THERMAL PROTECTION SYSTEM		2136.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1195.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		766.
ELECTRICAL SYSTEM	655.	
CONTROL SYSTEM	110.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		87631.
ENGINES (DRY)	57114.	
ACCESSORIES	416.	
GIMBAL SYSTEM	5883.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	8382.	
OXIDIZER SYSTEM	12073.	
SEPARATION AND RECOVERY SYSTEM		15244.
SEPARATION SYSTEM	2488.	
CHUTE SYS (MAIN AND DROGUE)	5096.	
FLOTATION SYSTEM	92.	
RECOVERY AID	91.	
FITTINGS AND SUPPORTS	175.	
RETRO SYS (100 FPS DEL V)	2625.	
REENTRY HEAT SHIELD	4876.	
STAGE DRY WEIGHT		208039.
CONTINGENCY		0.
EMPTY WEIGHT		208039.
PROPELLANT RESIDUALS		35899.
FUEL BIAS	1800.	
TRAPPED LOX TANK GASES	3709.	
TRAPPED FUEL TANK GASES	2994.	
FROST TRAPPED	401.	
TRAPPED FUEL	11373.	
TRAPPED LOX	15723.	
IN-FLIGHT LOSSES		3752.
FUEL LOSSES	1813.	
LOX LOSSES	1939.	
LRB INERT WT		242740.
MAIN PROPELLANTS		2179923.
FUEL	666643.	
LOX	1513280.	
BLOW		2427663.
MASS FRACTION (BASED ON INERT WT)		.8980

ORBITER WT	265754.0
ST WEIGHT	1904993.4
LRB WEIGHT	2427663.0
BLOW	4598410.4
STG 1 LAMBDA	.91153
STG 2 LAMBDA	.93217

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CONVERGENCE DATA:

GLOW	4598410.	79528.
ACTUAL PAYLOAD		
TOTAL WIDEAL	30956.7	
STAGE 1 WIDEAL		7791.6
STAGE 2 WIDEAL		23165.1
TOTAL PROPELLANT	3960946.	
LRB PROPELLANT		2179981.
ET PROPELLANT		1801025.
STAGE JETTISON WEIGHT		
STAGE 1 JETTISON WT		247740.
STAGE 2 JETTISON WT		103938.

STAGE 1 SIZING DATA

AVERAGE SP. IMP.	298.99
LIFT-OFF T/W	1.308
MAXIMUM Q	649.6
TIME AT MAX Q	71.0
STG 1 MAX LF	3.00
TIME AT MAX LF	114.0
EFF WDOT/LRB	18120.9
EFF WDOT/EVENT 1	21219.5

STAGING CONDITIONS:

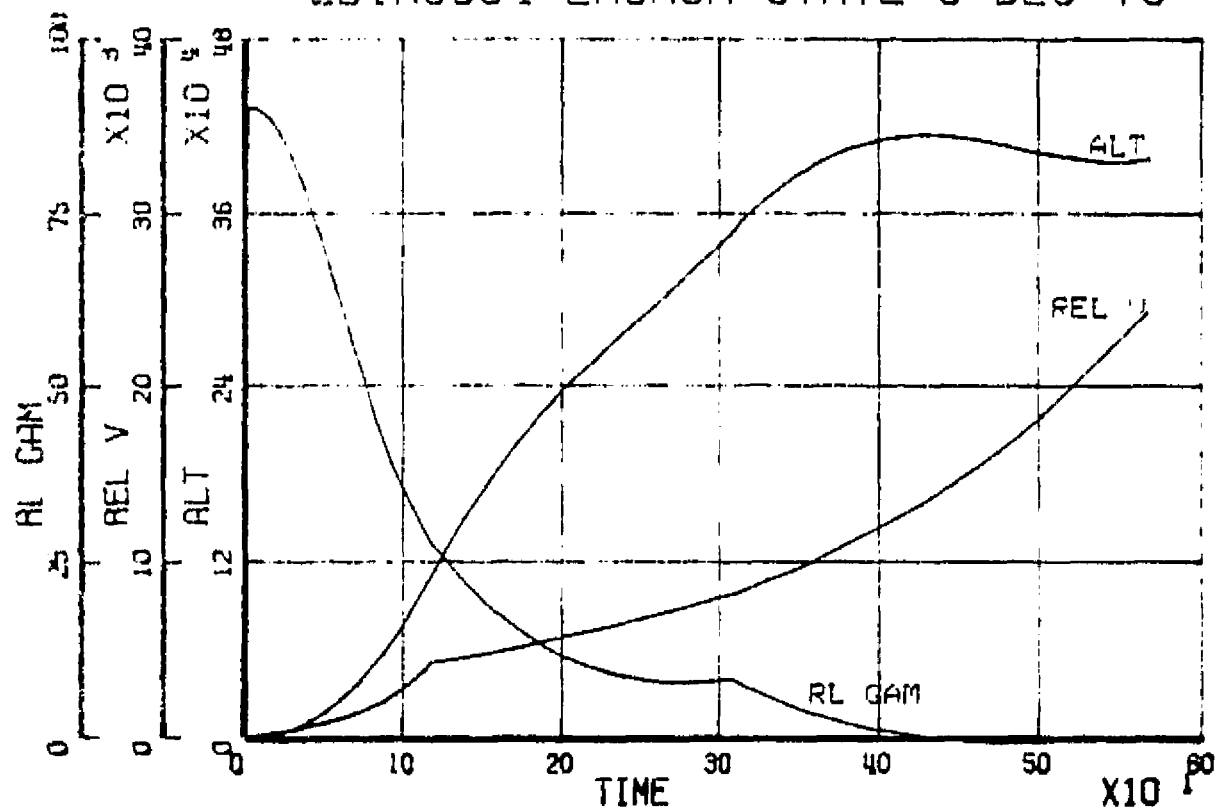
WEIGHT	2045720.
REL VELOCITY (FPS)	4250.7
REL F.P. ANGLE (DEG)	28.15
ALTITUDE (FT)	113461.
TIME (SEC)	120.30
ATT AFTER STG (DEG)	.94

MISSION SUMMARY: DECEMBER 8, 1975

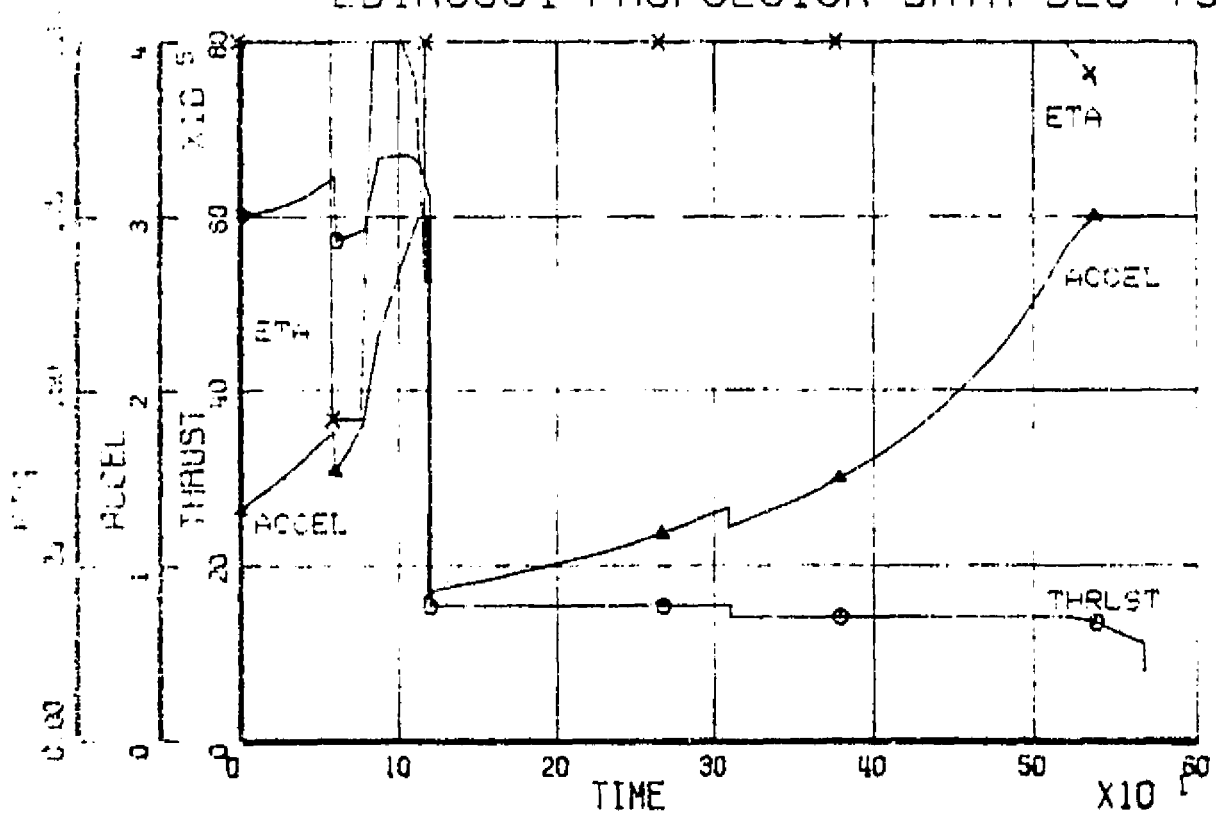
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4
TIME (SEC)	120.3	309.6	568.4	451.2
ALTITUDE (K FT)	113.5	349.0	396.4	0
REL VELOCITY (100 FPS)	42.5	81.4	243.1	2.072
REL GAMMA (DEG)	28.1	8.29	.552	-89.8
WEIGHT (K LBS)	4598.4	1798.0	1158.7	247.7
WEIGHT DROP (K LBS)	247.7	0	103.9	0
THROW WEIGHT (K LBS)	1798.0	1158.7	265.78	0
CUM WIDEAL (100 FPS)	77.92	142.3	309.6	0
DOWNRANGE (NMI)	20.87	225.8	918.5	223.0

EVENT 1	BECD/SEPARATION	EVENT 3	MECD-INJECTION
EVENT 2	RTLS-ROR CONSTRAINT	EVENT 4	LRB TOUCHDOWN

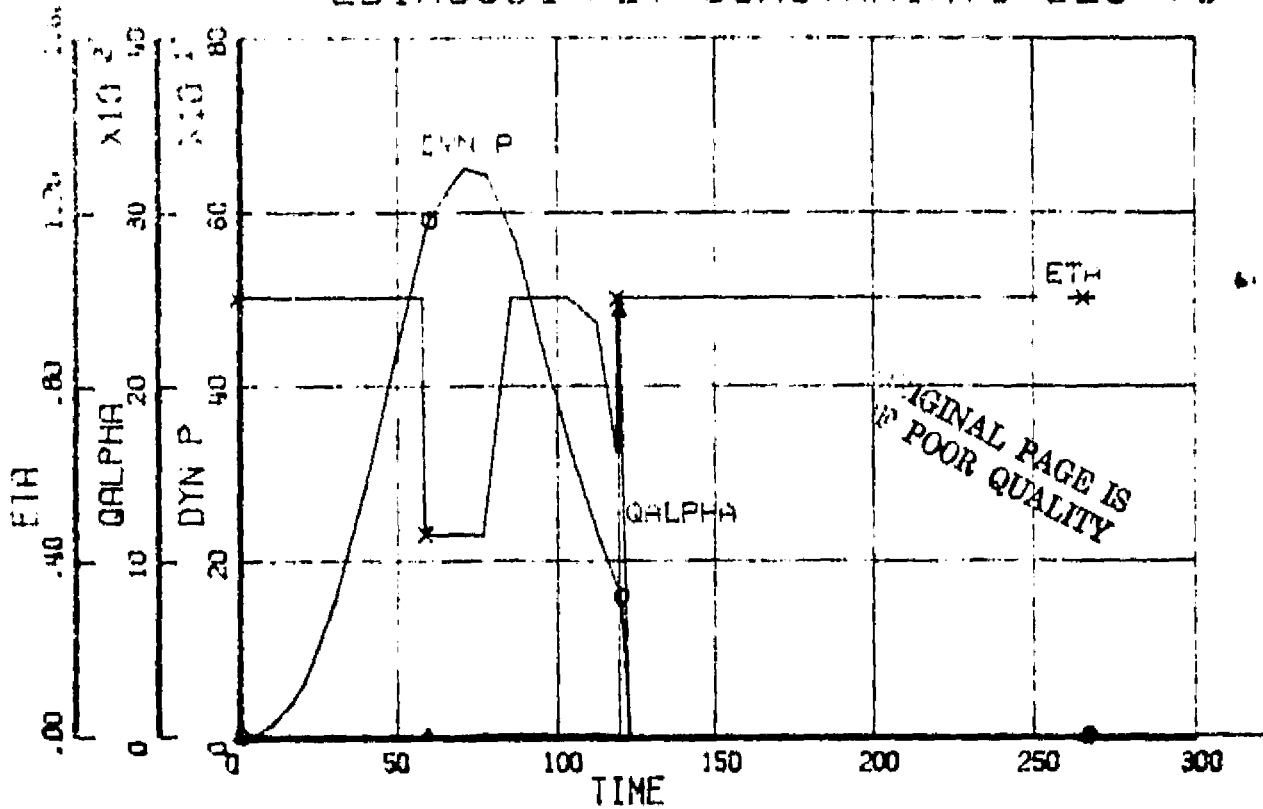
EDIN0504 LAUNCH STATE 8 DEC 75



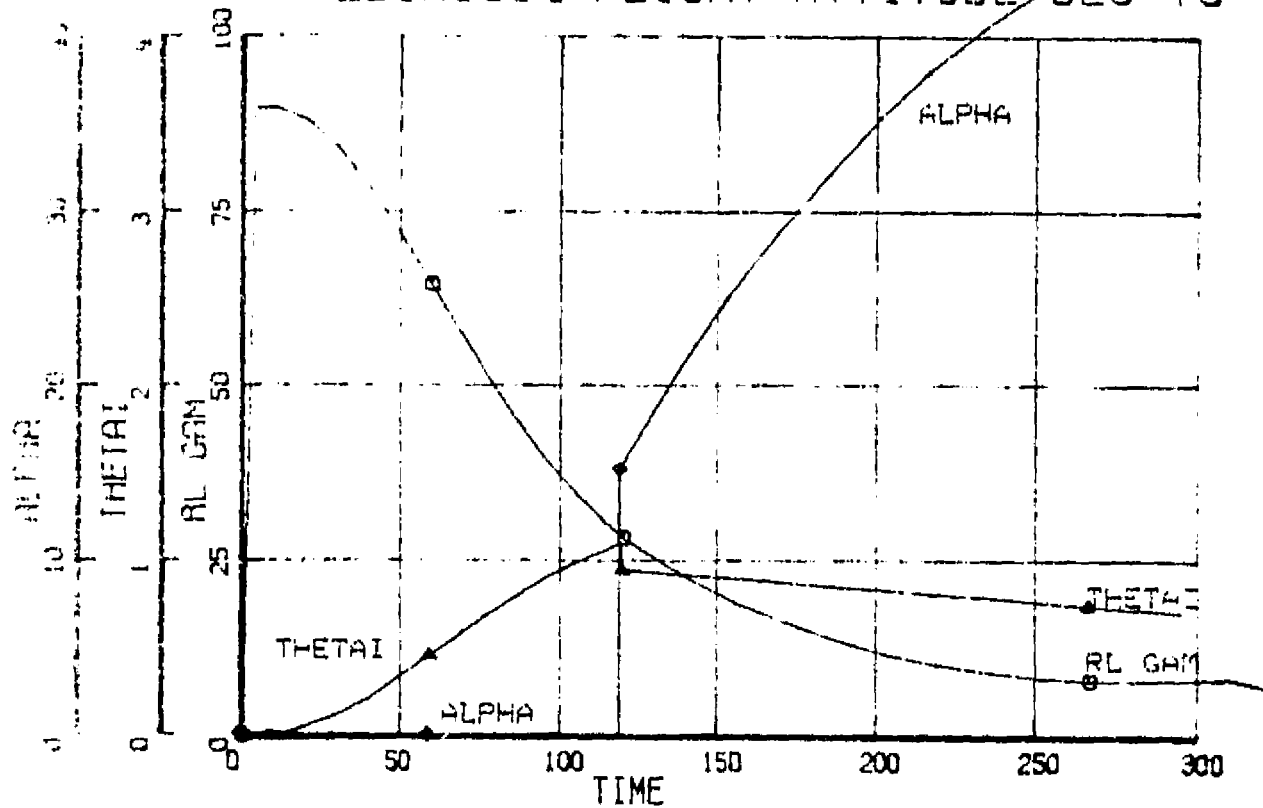
EDIN0504 PROPULSION DATA DEC 75



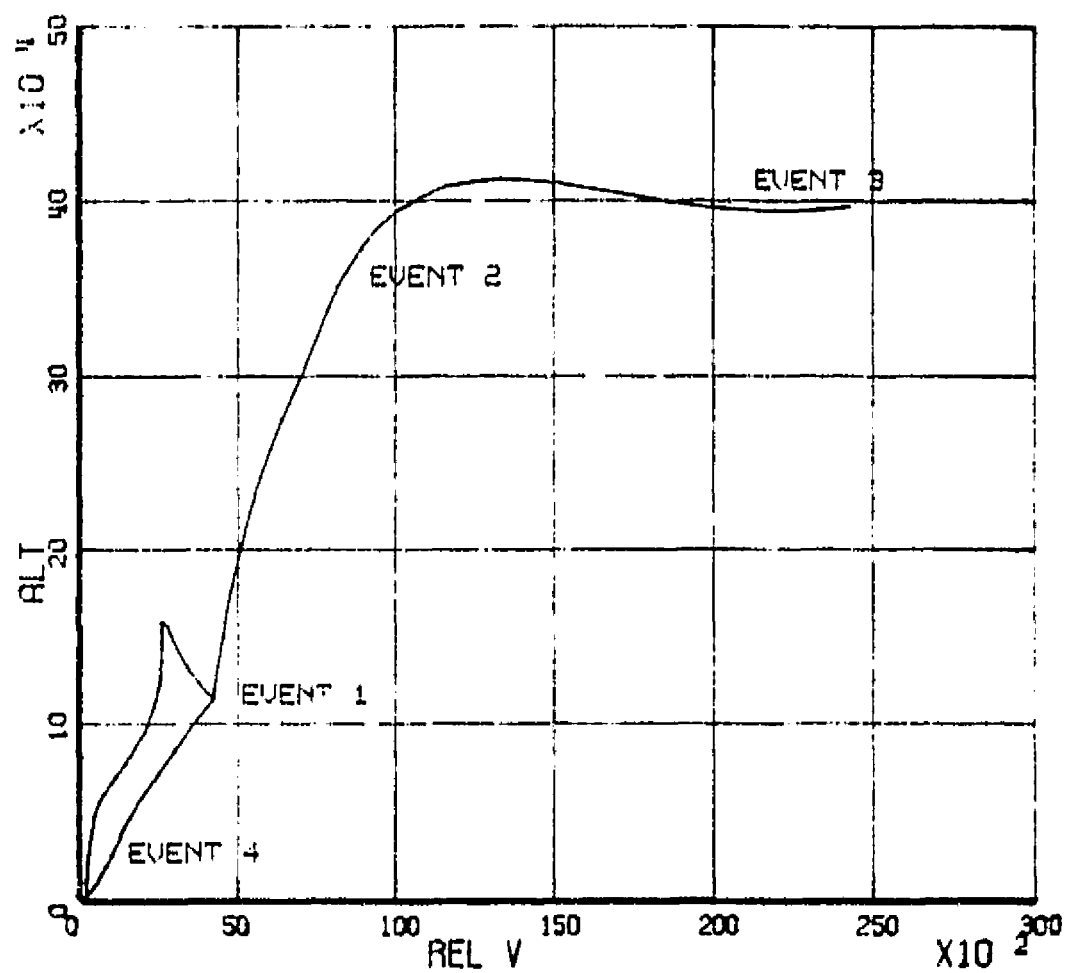
EDIN0504 FLT CONSTRAINTS DEC 75



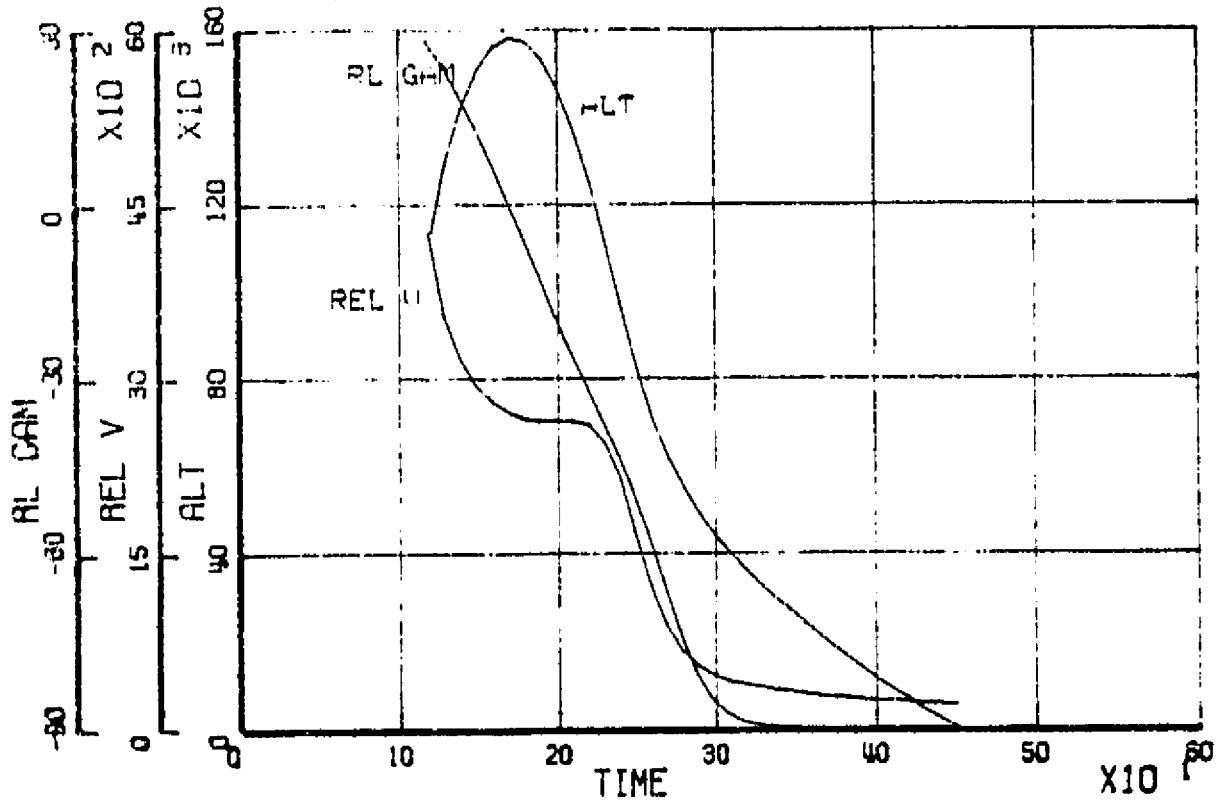
EDIN0504 FLIGHT ATTITUDE DEC 75



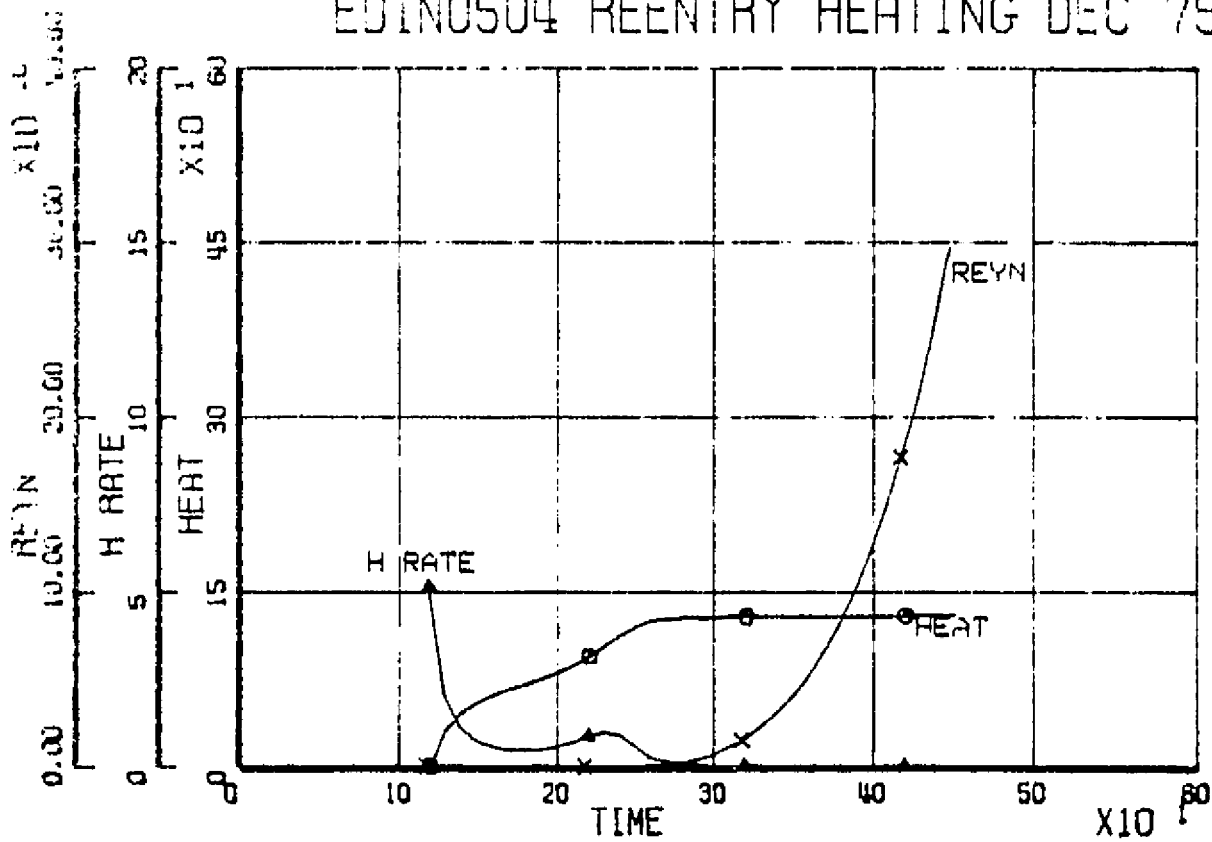
EDIN0504 H-V PROFILE 8 DEC 75



EDIN0504 LRB REENTRY STATE DEC 75



EDIN0504 REENTRY HEATING DEC 75



EDIN0504C DESIGN
SIMULATION RESULTS

 FORECASTER: EDIN DESIGN CENTER DATE: 9 DEC 75
 AFFILIATION: ENGINEERING ANALYSIS DIVISION-JSC TIME: 13:30
 STUDY NO: EDIN0504

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 7.71 HIGH
 PRESSURE ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR
 REPLACEMENT OF THE SOLID ROCKET BOOSTERS.

MISSION: 150000.0 LB PAYLOAD
 DUE EAST LAUNCH FROM ETR
 A 250 FPS OMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL
 MILE REFERENCE ORBIT.
 A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED ENO-ATMOSPHERIC PITCH
 PROFILE AND INITIAL TILT RATE.
 MID POINT CONSTRAINT = SHUTTLE MISSION 1 PTLS-ROA
 END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
 ATMOSPHERIC INFIGHT CONSTRAINTS CONTROLLED BY HIGH
 PRESSURE ENGINE THROTTLING AND/OR TIME THROTTLING.
 MAX DYNAMIC PRESSURE = 850.0 PSF
 MAX ACCELERATION = 3.0 G

PROPULSION: LRB: 7.71 HIGH PRESSURE ENGINES RATED AS FOLLOWS:

THRUST(SL) = 900000.00 LBS
 THRUST(VAC) = 966293.00 LBS
 THROTTLE = 1.00 TO .500
 ISP(SL) = 321.00 SEC.
 ISP(VAC) = 347.60 SEC.
 FLOWRATE = 2492.2 LB/SEC
 EXIT AREA = 32.000 SQ FT
 MIX RATIO = 2.50:1

ORBITER: THREE SSME ENGINES RATED AS FOLLOWS:

THRUST(SL) = 375000.00 LBS
 THRUST(VAC) = 470000.00 LBS
 THROTTLE = 1.00 TO .500
 ISP(SL) = 363.20 SEC
 ISP(VAC) = 455.20 SEC
 FLOWRATE = 1032.5 LB/SEC
 EXIT AREA = 44.896 SQ FT
 MIX RATIO = 6.00:1

AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION
 WERE OBTAINED FROM SHUTTLE REPO ESTIMATES. ADJUSTMENTS
 WERE MADE TO THE REFERENCE AREA FOR SPB DELETION.
 REF AREA = 2557.0 SQ FT

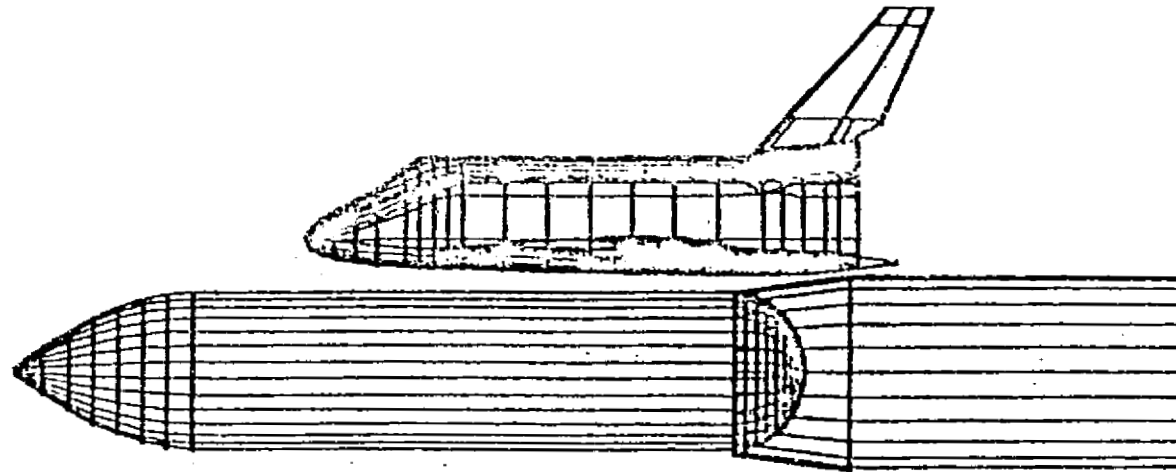
◆TB◆DEMAND SUPPORT ENDS IN 25 MINUTES ◆◆◆◆◆◆◆◆◆◆

STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS
 ARE INCLUDED FOR DELETION OF THE SPB/ET ATTACHMENTS AND
 INCREASED UP PAYLOADS.

MASS PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC
 ASSUMPTIONS.

LRB: WERS BASED ON SATURN TECHNOLOGY.
 ET: FIXED MASS FRACTION DISTRIBUTED IN
 ACCORDANCE WITH SHUTTLE ET WEIGHT
 STATEMENT.
 ORBITER: FEB 1975 SHUTTLE WITH MODS FOR
 INCREASED UP PAYLOAD.

EDIN0504C DESIGN SIMULATION RESULTS



WEIGHTS SUMMARY REPORT

GLOW	4586902.56
ET LIFT-OFF WEIGHT	1351372.48
ET INERT WEIGHT	75160.791
ET PROPELLANT	1278212.00
LRB LIFT-OFF WEIGHT	2897716.25
LRB INERT WEIGHT	255852.27
LRB PROPELLANT	2641864.03
ORBITER LIFT-OFF WEIGHT	337814.00
ORBITER INERT WEIGHT	187314.00
PAYLOAD	150000.00

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	3862.	
BODY GROUP	43291.	
INDUCED ENVIRON PROTECT	13874.	
LANDING & AUX SYSTEMS	7683.	
PROPULSION-ASCENT	38054.	
PROPULSION-POS	2657.	
PROPULSION-OMS	3908.	
PRIME POWER	3329.	
ELECTRICAL CONVERSION	6380.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2739.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 150K PAYLD	950.	
ORBITER EMPTY WEIGHT		152275.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	3024.	
PROPELLANT-POS	6241.	
PROPELLANT-OMS	16149.	
ORBITER INERT WEIGHT		137814.
PAYLOAD		150000.
ORBITER PRELAUNCH WEIGHT		337814.

EXTERNAL TANK WEIGHT STATEMENT:

LOX TANK		12153.
BHD	59.	
FWD FRAME	38.	
FWD OGIVE	1003.	
AFT OGIVE	3372.	
XT 745 FRAME	234.	
BARREL	2180.	
INTERTANK FRAME	796.	
AFT DOME	2593.	
SLOSH BAFFLES	1379.	
INTERTANK		9438.
MACHINED BARREL PNLS	3803.	
EX/STGR BARREL PNLS	4111.	
STABILIZING FRAMES(4)	1125.	
SRB THRST XT 325 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	51.	
BARREL PNLS SPLICES (8)	64.	
FRAME STABILIZERS	182.	
ET ASSY FASTENERS	142.	

LH2 TANK		29514.
AND DOME	1422.	
XT 1129.9 FRAME	1403.	
BARREL NO.4	4877.	
XT 1377 FRAME	489.	
BARREL NO.3	4903.	
XT 1624 FRAME	489.	
BARREL NO.2	4905.	
XT 1871 FRAME	1537.	
BARREL NO.1	5138.	
XT 2058 FRAME	2937.	
AFT DOME	1663.	
THERMAL PROTECTION		5777.
LOX TANK	1239.	
INTERTANK	1286.	
LH2 TANK	3017.	
PROP (MECH+ELEC)	235.	
PROPULSION AND MECHANICAL SYSTEMS		3366.
LOX FEED SYS	1439.	
LOX ANTIGEYER SYS	135.	
LOX VENT SYS	76.	
LOX PRESS. SYS	164.	
LH2 FEED SYS	412.	
LH2 RECIR. SYS	27.	
LH2 VENT SYS	115.	
LH2 PRESS. SYS	121.	
HELIUM INJ. SYS	19.	
INTERTANK PURGE SYS	71.	
HAZARD GAS DETECTION SYS	7.	
PAIRINGS AND CONDUIT	304.	
LINE SUPTS. AND ATTACHS.	476.	
ELECTRICAL SYSTEM		206.
ET WIRING ASSY	141.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	13.	
CABLING ATTACHS.+SENSOR SUPTS.	55.	
ORB/SRB ATTACHMENTS		4004.
ORBITER SUPPORTS	2748.	
UMBILICAL BEAM	563.	
ORB/ET ATTACH FTGS	209.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL HDWR	484.	
MANUFACTURING VARIATION WT.		379.
EMPTY WEIGHT		65199.
UNUSABLE FLUIDS		364.
LH2 IN TANK	204.	
LH2 IN LINE	42.	
LOX IN LINE	117.	
PRE-PRESS.+INFLIGHT GASES		3293.
GH2	856.	
GDM	2409.	
HELIUM	28.	
SEPARATION HARDWARE		4.
SRB SUPPORTS	0.	
ORB FITTINGS	4.	
FLT PERF RES		6301.
ET INERT WT		75161.
MAIN PROPELLANTS		1276212.
LOX	1093896.	
LH2	182316.	
ET LIFT-OFF WEIGHT		1351372.
MASS FRACTION BASED ON INERT WEIGHT		.94438

LIQUID ROCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		103821.
INTEGRAL LOX TANK	22433.	
INTEGRAL FUEL TANK	13813.	
INTERSTAGE	3583.	
AFT SHIRT	16159.	
THRUST STRUCTURE	42833.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		2222.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1281.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		820.
ELECTRICAL SYSTEM	702.	
CONTROL SYSTEM	118.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		77304.
ENGINES (DRY)	48931.	
ACCESSORIES	357.	
GIMBAL SYSTEM	4531.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	7312.	
OXIDIZER SYSTEM	11663.	
SEPARATION AND RECOVERY SYSTEM		16667.
SEPARATION SYSTEM	2483.	
CHUTE SYS (MAIN AND DROGUE)	5725.	
FLOTATION SYSTEM	104.	
RECOVERY AIDS	102.	
FITTINGS AND SUPPORTS	197.	
RETRO SYS (100 FPS DEL V)	3174.	
REENTRY HEAT SHIELD	4276.	
STAGE DRY WEIGHT		209170.
CONTINGENCY		0.
EMPTY WEIGHT		209170.
PROPELLANT RESIDUALS		42212.
FUEL BIAS	1300.	
TRAPPED LOX TANK GASES	4199.	
TRAPPED FUEL TANK GASES	3388.	
FROST TRAPPED	454.	
TRAPPED FUEL	12764.	
TRAPPED LOX	19606.	
IN-FLIGHT LOSSES		4471.
FUEL LOSSES	2053.	
LOX LOSSES	2418.	
LRB INERT MT		255852.
MAIN PROPELLANTS		2641964.
FUEL	754818.	
LOX	1887046.	
BLOW		2897716.
MASS FRACTION (BASED ON INERT MT)		.91171

ORBITER MT	337814.0
ET WEIGHT	1351372.5
LRB WEIGHT	2897716.2
GLOW	4586302.7
STG 1 LAMBDA	.91171
STG 2 LAMBDA	.94433

CONVERGENCE DATA:

GLOW	4536903.	
TARGET PAYLOAD	150000.	
ACTUAL PAYLOAD		150393.
TOTAL VIDEAL	30065.5	
STAGE 1 VIDEAL		9982.4
STAGE 2 VIDEAL		20083.1
TOTAL PROPELLANT	2917694.	
LPB PROPELLANT		2641520.
ET PROPELLANT		1275974.
STAGE JETTISON WEIGHT		
STAGE 1 JETTISON WT		255652.
STAGE 2 JETTISON WT		75161.

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STAGE 1 SIZING DATA

AVERAGE SP. IMP.	340.13
START-OFF T/M	1.345
MAXIMUM Q	650.3
TIME AT MAX Q	73.3
1 MAX LF	3.00
TIME AT MAX LF	125.0
Q DOT/LPB	19087.9
Q DOT/EVENT 1	19087.9

STAGING CONDITIONS:

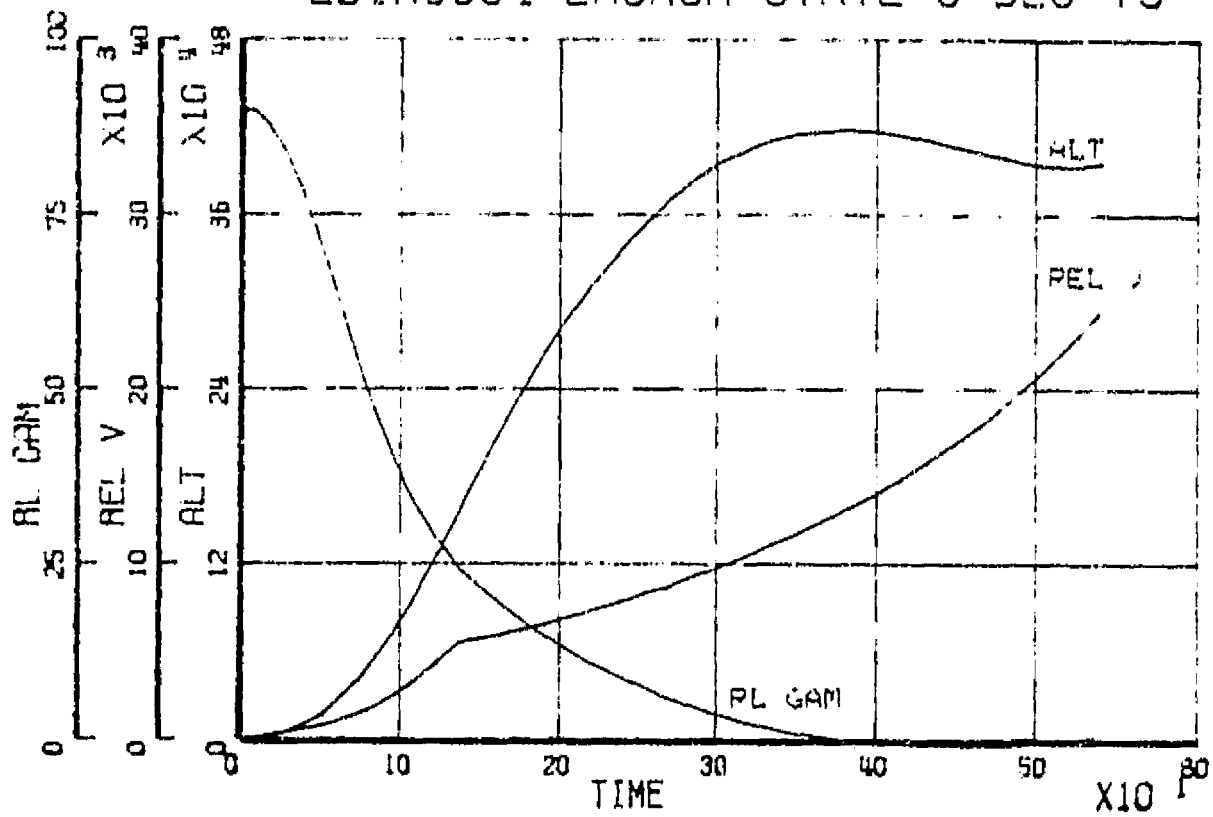
WEIGHT	1945083.
REL VELOCITY (FPS)	5556.9
REL F.P. ANGLE (DEG)	24.68
ALTITUDE (FT)	158036.
TIME (SEC)	138.40
ATT AFTER STG (DEG)	.95

MISSION SUMMARY: DECEMBER 9, 1975

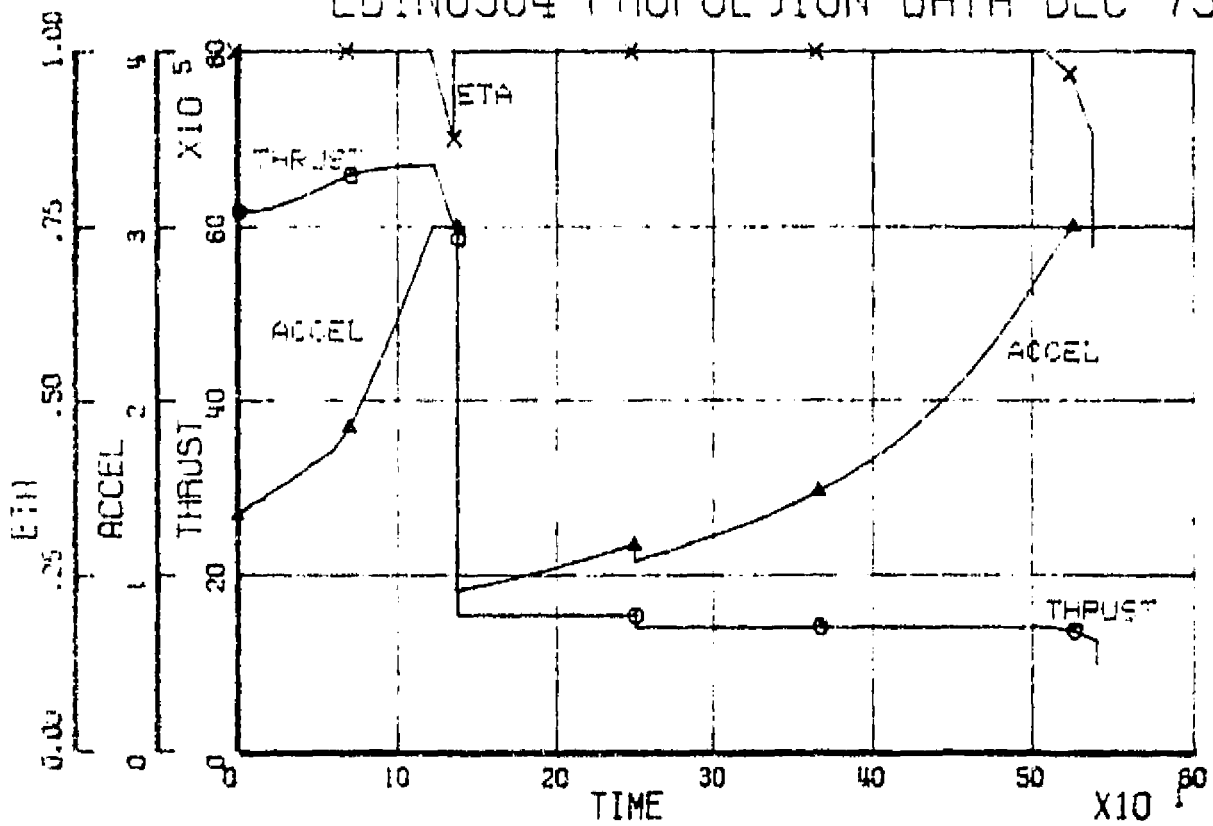
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4
TIME (SEC)	138.4	250.1	541.5	522.1
ALTITUDE (K FT)	158.0	348.6	394.4	0
REL VELOCITY (100 FPS)	55.6	81.4	243.0	2.107
REL GAMMA (DEG)	24.7	8.27	.528	-89.8
WEIGHT (K LBS)	4586.9	1689.2	1312.0	255.9
WEIGHT DROP (K LBS)	255.9	0	75.16	0
THROW WEIGHT (K LBS)	1689.2	1312.0	338.20	0
CUM VIDEAL (100 FPS)	33.68	130.3	300.1	0
DOWNRANGE (NM)	34.48	167.8	938.9	192.5

EVENT 1	BECD/SEPARATION	EVENT 3	MECD-INJECTION
EVENT 2	ATL/ADR CONSTRAINT	EVENT 4	LPB TOUCHDOWN

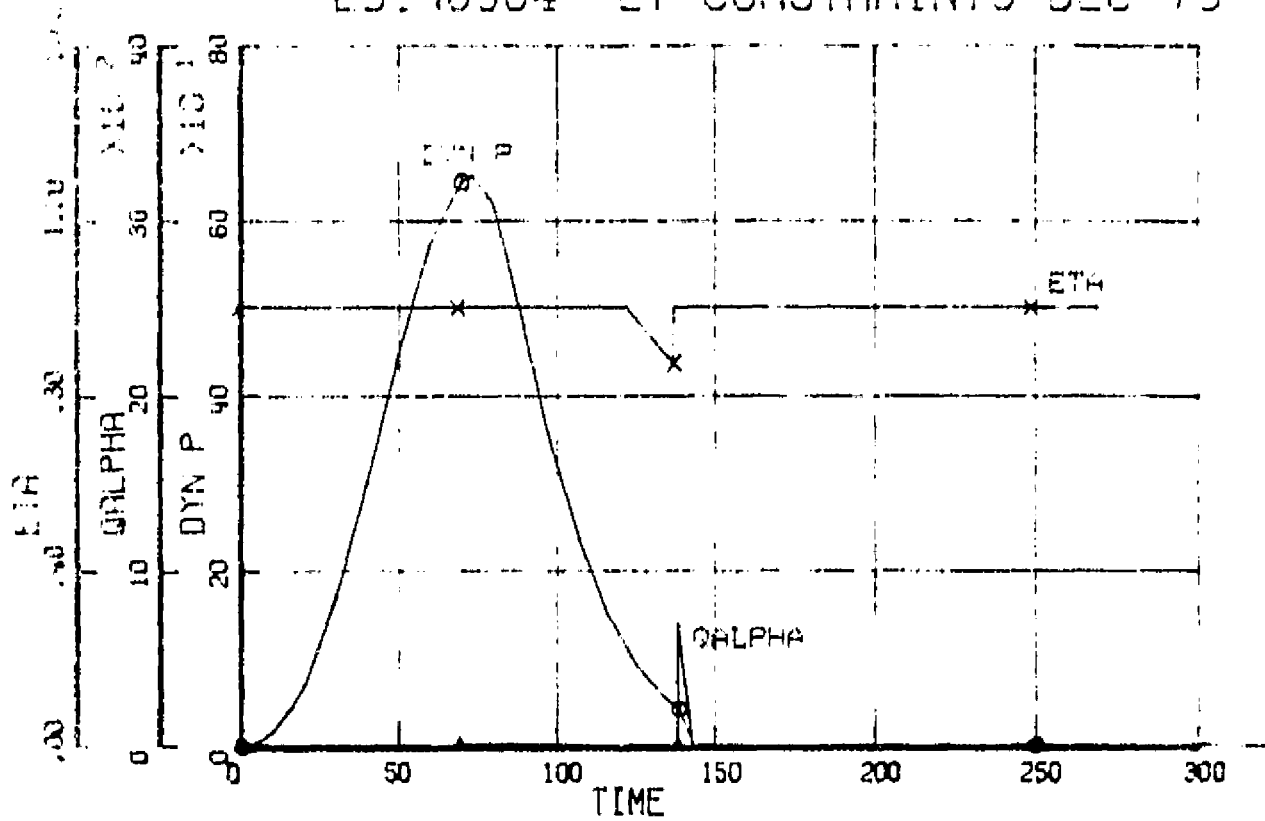
EDINO504 LAUNCH STATE 9 DEC 75



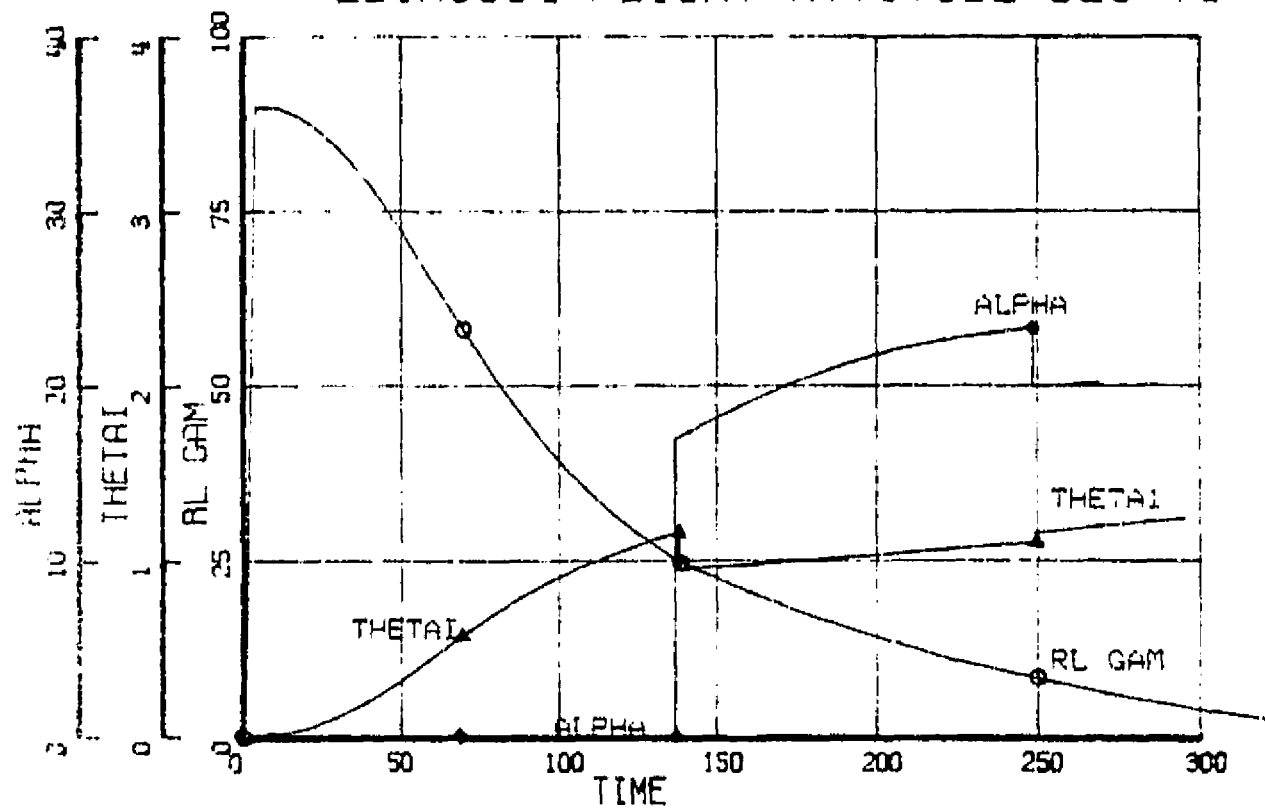
EDINO504 PROPULSION DATA DEC 75



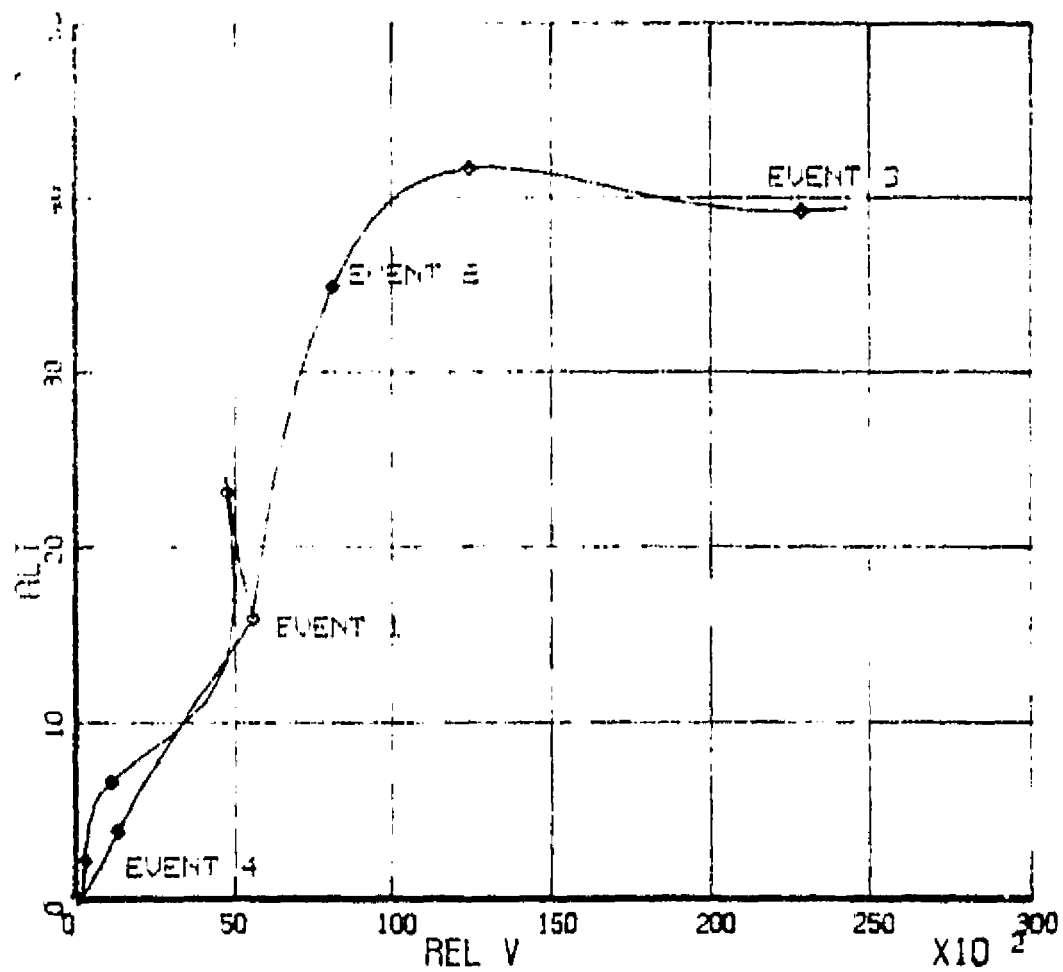
EDIN0504 FLT CONSTRAINTS DEC 75



EDIN0504 FLIGHT ATTITUDE DEC 75

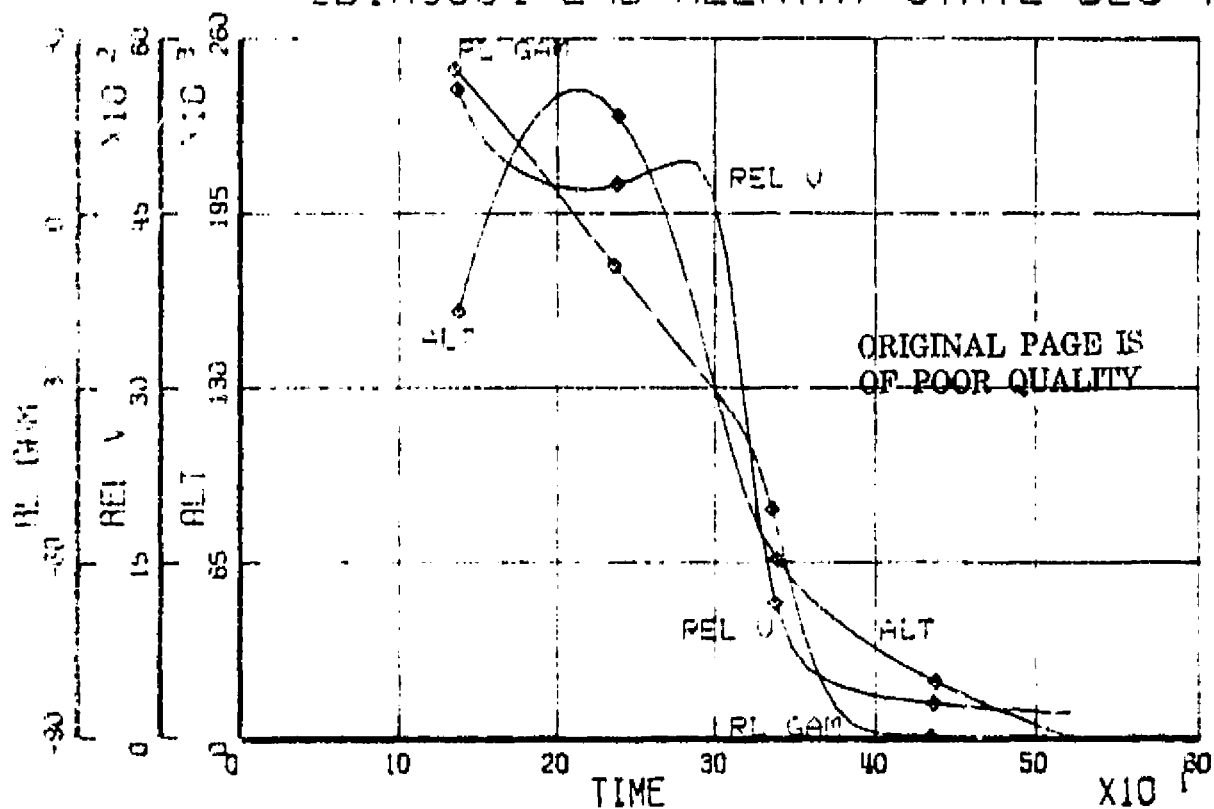


FDIN0504 H-V PROFILE 9 DEC 75

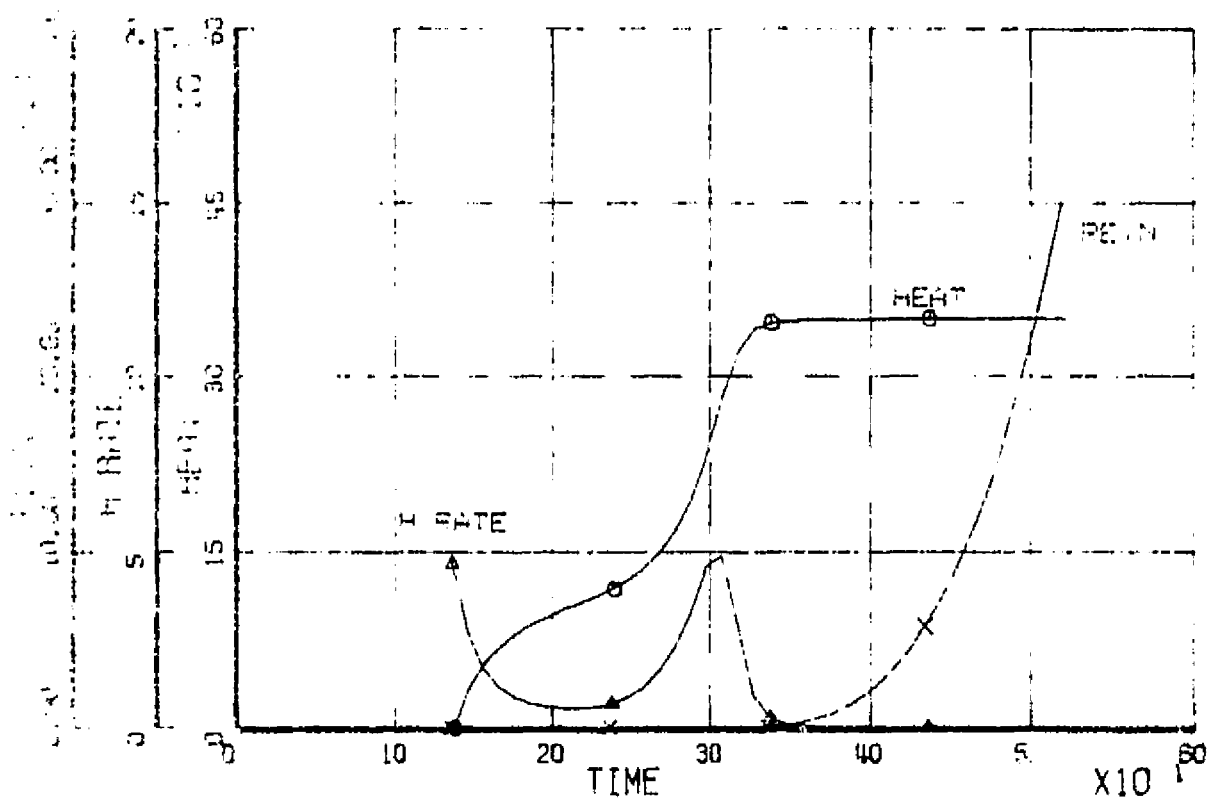


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EDING504 LRB REENTRY STATE DEC 75



EDING504 REENTRY HEATING DEC 75



EDIN0504D DESIGN
SIMULATION RESULTS

FORECASTER: EDIN DESIGN CENTER DATE: 9 DEC 75
AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC TIME: 19:49
STUDY NO: EDIN0504

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 4.000 F-1
ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR REPLACEMENT
OF THE SOLID ROCKET BOOSTERS.

MISSION: MAXIMUM PAYLOAD
DUE EAST LAUNCH FROM ETP
A 250 FPS OMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL
MILE REFERENCE ORBIT.
A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED END-ATMOSPHERIC FITCH
PROFILE AND INITIAL TILT RATE.
MID POINT CONSTRAINT = SHUTTLE MISSION 1 RTL3/ADR
END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
ATMOSPHERIC INFLIGHT CONSTRAINTS CONTROLLED BY ONE F1
ENGINE SHUTDOWN AND/OR SOME THROTTLING.
MAX DYNAMIC PRESSURE = 650.0 PSF
MAX ACCELERATION = 3.0 G

PROPULSION: LRB: 4.000 F-1 ENGINES RATED AS FOLLOWS:
THRUST(SL) = 1506788.5 LBS
THRUST(VAC) = 1748060.0 LBS
ICP(SL) = 266.01 SEC.
ICP(VAC) = 289.40 SEC.
FLOWRATE = 6040.3 LB/SEC
EXIT AREA = 66.763 SQ FT
MIX RATIO = 2.27:1
ORBITER: THREE SOME ENGINES RATED AS FOLLOWS:
THRUST(SL) = 375000.00 LBS
THRUST(VAC) = 470000.00 LBS
THROTTLE = 1.09 TO .500
ISP(SL) = 363.20 SEC
ISP(VAC) = 455.20 SEC
FLOWRATE = 1032.5 LB/SEC
EXIT AREA = 44.396 SQ FT
MIX RATIO = 6.00:1

AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION
WERE OBTAINED FROM SHUTTLE AERD ESTIMATES. ADJUSTMENTS
WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
REF AREA = 2557.0 SQ FT

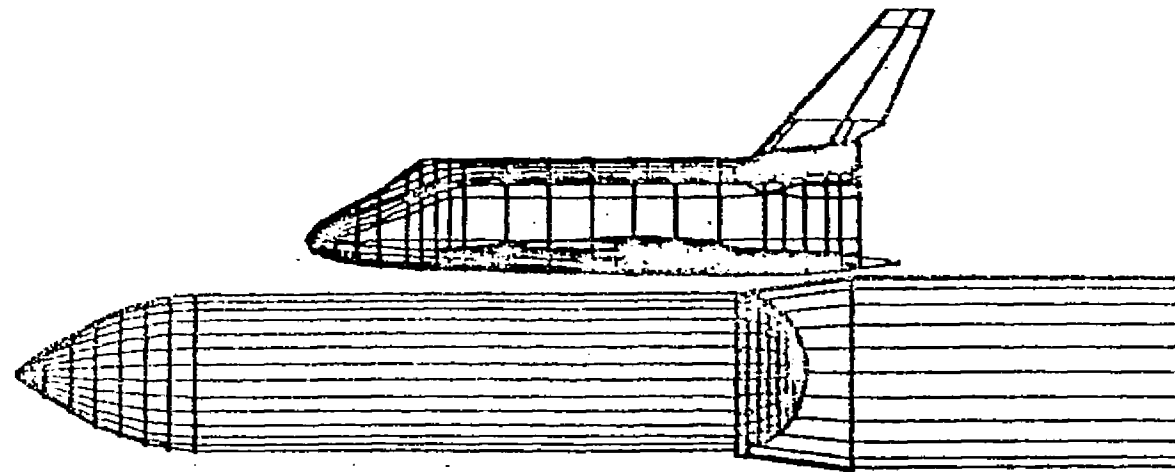
STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS
ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND
INCREASED UP PAYLOADS.

MASS PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC
ASSUMPTIONS.

LRB: WERE BASED ON SATURN TECHNOLOGY.
ET: FIXED MASS FRACTION DISTRIBUTED IN
ACCORDANCE WITH SHUTTLE ET WEIGHT
STATEMENT.
ORBITER: FEB 1975 SHUTTLE WITH MODS FOR
INCREASED UP PAYLOAD.

EDIN0504D DESIGN SIMULATION RESULTS

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WEIGHTS SUMMARY REPORT

GLOW	4344480.00
ET LIFT-OFF WEIGHT	1323613.39
ET INERT WEIGHT	75160.790
ET PROPELLANT	1248452.60
LRB LIFT-OFF WEIGHT	2760267.72
LRB INERT WEIGHT	292011.79
LRB PROPELLANT	2468255.91
ORBITER LIFT-OFF WEIGHT	260579.00
ORBITER INERT WEIGHT	187254.00
PAYLOAD	73325.000

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	2862.	
BODY GROUP	43291.	
INDUCED ENVIRON PROTECT	12874.	
LANDING & AUX SYSTEMS	7683.	
PROPULSION-ASCENT	28054.	
PROPULSION-RCS	2657.	
PROPULSION-QMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2733.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 100K PAYLD	390.	
ORBITER EMPTY WEIGHT		151715.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PRO ULSION	5024.	
PROPELLANT-RCS	6241.	
PROPELLANT-QMS	16149.	
ORBITER INERT WEIGHT		137254.
PAYLOAD		73325.
ORBITER PRELAUNCH WEIGHT		260579.

EXTERNAL TANK WEIGHT STATEMENT:

LOW TANK		12153.
BHD	53.	
FWD FRAME	38.	
FWD OGIVE	1003.	
AFT OGIVE	3372.	
WT 745 FRAME	234.	
BARREL	2180.	
INTERTANK FRAME	796.	
AFT DOME	2593.	
BLOSH BAFFLES	1279.	
INTERTANK		3498.
MACHINED BARREL PNLS	3803.	
SKETCH BARREL PNLS	4111.	
STABILIZING FRAMES(4)	1125.	
ORB THRST MT 225 FRAME	0.	
ORB THRST BEAM	0.	
ORB THRST FITTINGS (2)	0.	
ACCESS DOOR	51.	
BARREL PNLS (PLICES (8)	84.	
FRAME STABILIZERS	182.	
ET ASSY FASTENERS	142.	

LH2 TANK		13914.
FWD DOME	1482.	
WT 1129.9 FRAME	1400.	
BARREL NO.4	4870.	
WT 1377 FRAME	489.	
BARREL NO.3	4903.	
WT 1624 FRAME	489.	
BARREL NO.2	4905.	
WT 1871 FRAME	1537.	
BARREL NO.1	5193.	
WT 2058 FRAME	2937.	
AFT DOME	1663.	
THERMAL PROTECTION		5777.
LOX TANK	1239.	
INTERTANK	1284.	
LH2 TANK	3617.	
PROP (MECH+ELEC)	235.	
PROPULSION AND MECHANICAL SYSTEM:		3366.
LOX FEED SYS	1439.	
LOX ANTIGEYER SYS	135.	
LOX VENT SYS	76.	
LOX PRESS. SYS	164.	
LH2 FEED SYS	412.	
LH2 RECIR. SYS	27.	
LH2 VENT SYS	115.	
LH2 PRESS. SYS	121.	
HELIUM INJ. SYS	19.	
INTERTANK PURGE SYS	71.	
HAZARD GAS DETECTION SYS	7.	
FAIRINGS AND CONDUIT	304.	
LINE SUPTS. AND ATTACH.	476.	
ELECTRICAL SYSTEM		208.
ET WIRING ASSY	141.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	13.	
CABLING ATTACHS.+SENSOR SUPTS.	55.	
ORB/SRB ATTACHMENTS		4004.
ORBITER SUPPORTS	2746.	
UMBILICAL BEAM	563.	
ORB/ET ATTACH FTGS	209.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL HDMF	484.	
MANUFACTURING VARIATION WT.		378.
EMPTY WEIGHT		65199.
UNUSABLE FLUIDS		364.
LH2 IN TANK	204.	
LH2 IN LINE	42.	
LOX IN LINE	117.	
PRE-PRESS.+INFLIGHT GASES		3293.
GH2	856.	
GON	2409.	
HELIUM	28.	
SEPARATION HARDWARE		4.
SRB SUPPORTS	0.	
ORB FITTINGS	4.	
FLT PERF RES		4301.
ET INERT WT		15121.
MAIN PROPELLANTS		1279312.
LOX	1093894.	
LH2	162316.	
ET LIFT-OFF WEIGHT		1281372.
MASS FRACTION (BASED ON INERT WEIGHT)		1.54435

LIQUID ROCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		103821.
INTEGRAL LOX TANK	22433.	
INTEGRAL FUEL TANK	13813.	
INTERSTAGE	5583.	
AFT CHIPT	16159.	
THROAT STRUCTURE	42833.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		2222.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1281.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		820.
ELECTRICAL SYSTEM	702.	
CONTROL SYSTEM	118.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		115290.
ENGINES (DRY)	76152.	
ACCESSORIES	555.	
GIMBAL SYSTEM	7044.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	11125.	
OXIDIZER SYSTEM	16038.	
SEPARATION AND RECOVERY SYSTEM		16667.
SEPARATION SYSTEM	2428.	
CHUTE SYS (MAIN AND DROGUE)	5725.	
FLOTATION SYSTEM	104.	
RECOVERY AIDS	102.	
FITTINGS AND SUPPORTS	127.	
RETRO SYS (100 F/S DEL V)	3174.	
REENTRY HEAT SHIELD	4876.	
STAGE DRY WEIGHT		247356.
CONTINGENCY		0.
EMPTY WEIGHT		247356.
PROPELLANT RESIDUALS		40408.
FUEL BIAS	1900.	
TRAPPED LOX TANK GASES	4199.	
TRAPPED FUEL TANK GASES	3383.	
FROST TRAPPED	454.	
TRAPPED FUEL	12764.	
TRAPPED LOX	17803.	
IN-FLIGHT LOSSES		4242.
FUEL LOSSES	2053.	
LOX LOSSES	2195.	
LRB INERT MT		292012.
MAIN PROPELLANTS		2462856.
FUEL	754818.	
LOX	1713438.	
BLOW		2760268.
MASS FRACTION (BASED ON INERT MT)		.8942

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ORBITER MT	260579.0
ET WEIGHT	1323613.4
LRB WEIGHT	2760267.7
GLOW	4344460.1
STG 1 LAMBDA	.89421
STG 2 LAMBDA	.94438

CONVERGENCE DATA:

SLOW	4344460.	73388.
ACTUAL PAYLOAD		
TOTAL VIDEAL	30326.5	
STAGE 1 VIDEAL		7603.3
STAGE 2 VIDEAL		22722.7
TOTAL PROPELLANT	3716706.	
LRB PROPELLANT		2468256.
ET PROPELLANT		1248450.
STAGE JETTISON WEIGHTS		
STAGE 1 JETTISON WT		292012.
STAGE 2 JETTISON WT		75161.

STAGE 1 SIZING DATA

AVERAGE SP. IMP.	281.47
LIFT-OFF T/M	1.479
MAXIMUM Q	646.1
TIME AT MAX Q	45.7
STG 1 MAX LF	2.76
TIME AT MAX LF	120.0
EFF MDOT/LRB	20405.5
EFF MDOT/EVENT 1	20405.5

STAGING CONDITIONS:

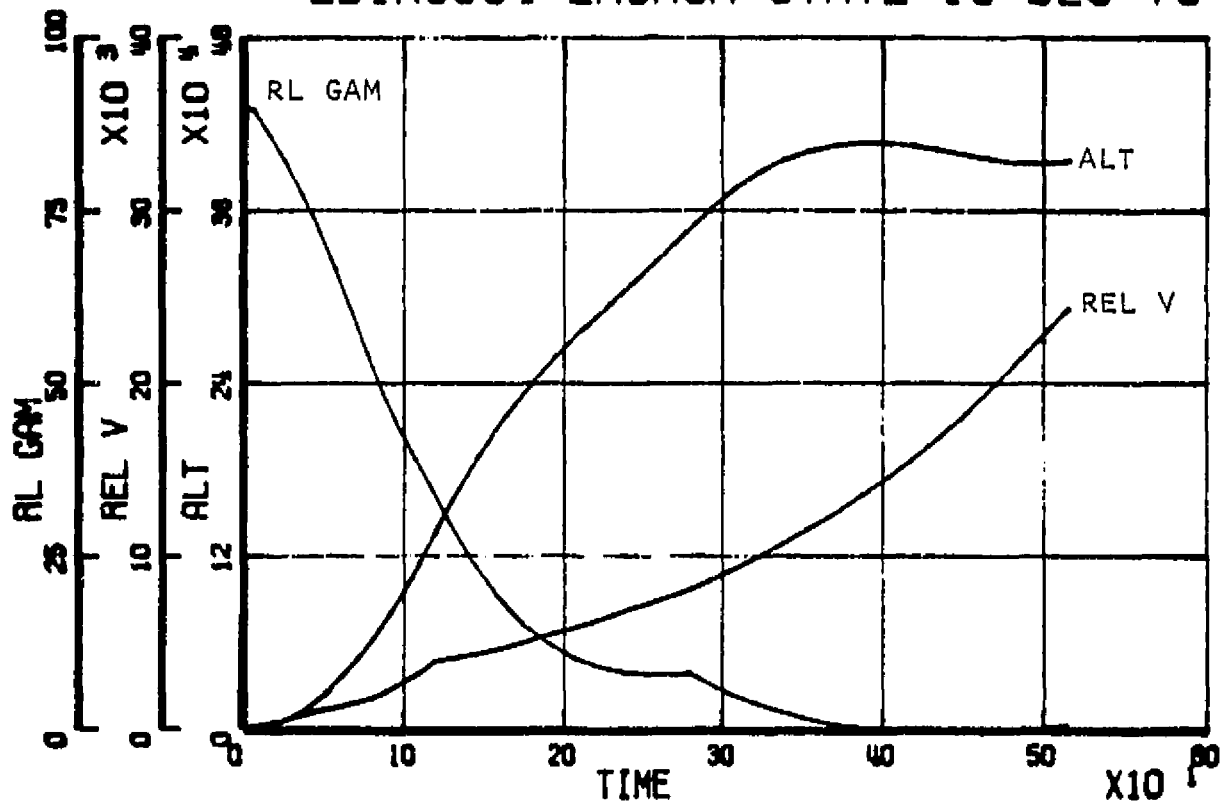
WEIGHT	1376204.
REL VELOCITY (FPS)	3956.7
REL F.P. ANGLE (DEG)	34.44
ALTITUDE (FT)	137056.
TIME (SEC)	120.96
ATT AFTER STG (DEG)	1.24

MISSION SUMMARY

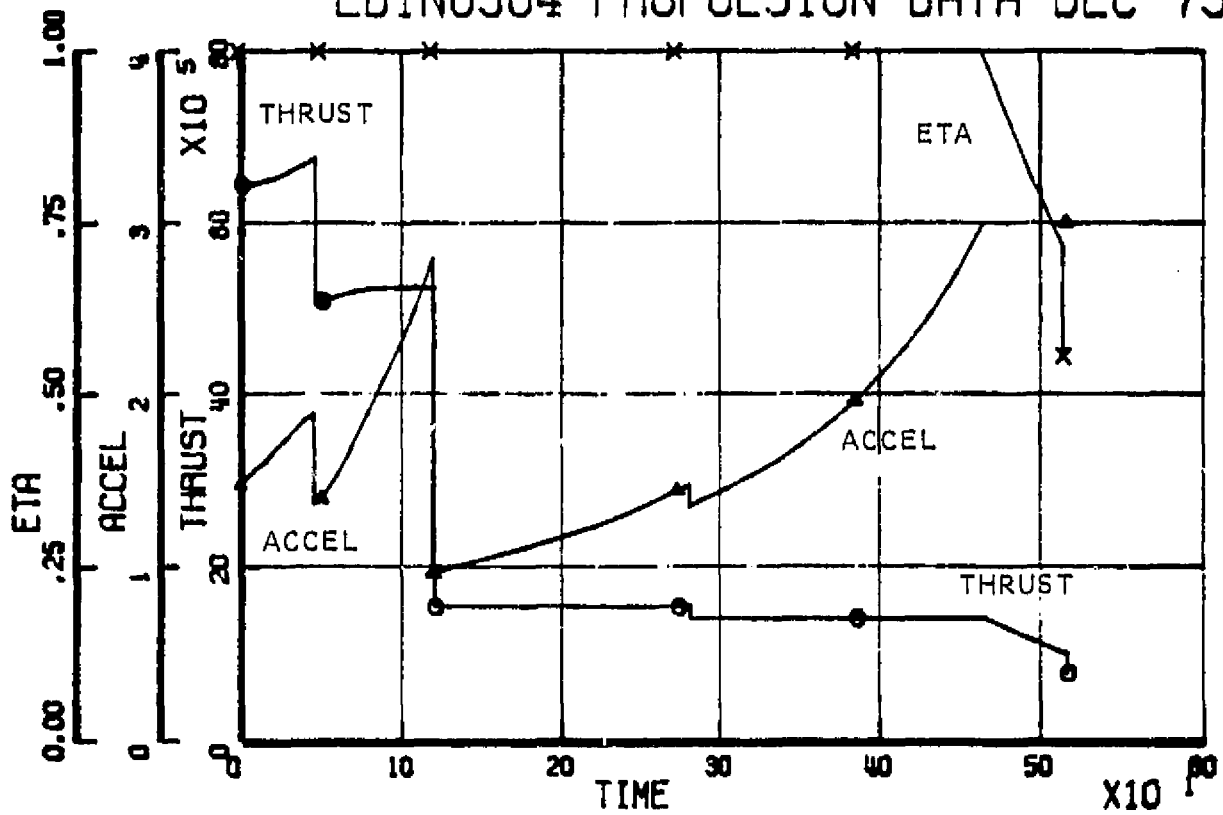
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4	EVENT 5
TIME (SEC)	45.75	121.0	281.1	517.2	467.0
ALTITUDE (K FT)	20.5	137.1	348.6	394.6	0
REL VELOCITY (100 FPS)	10.3	39.6	81.4	243.0	2.25
REL GAMMA (DEG)	73.8	34.4	8.27	.528	-89.8
WEIGHT (K LBS)	4344.5	3239.1	1584.2	1043.3	292.0
WEIGHT DROP (K LBS)	0	292.0	0	75.2	0
THROW WEIGHT (K LBS)	3239.1	1584.2	1043.3	260.6	0
CUM VIDEAL (100 FPS)		76.0	137.2	303.3	0
DOWNRANGE (NMI)	0.65	19.98	186.5	826.7	110.9

EVENT 1	ONE F-1 ENGINE SHUTDOWN	EVENT 3	RTLS/AOA CONSTRAINT
EVENT 2	BECO/SEPARATION	EVENT 4	MECO/INJECTION
		EVENT 5	LRB TOUCHDOWN

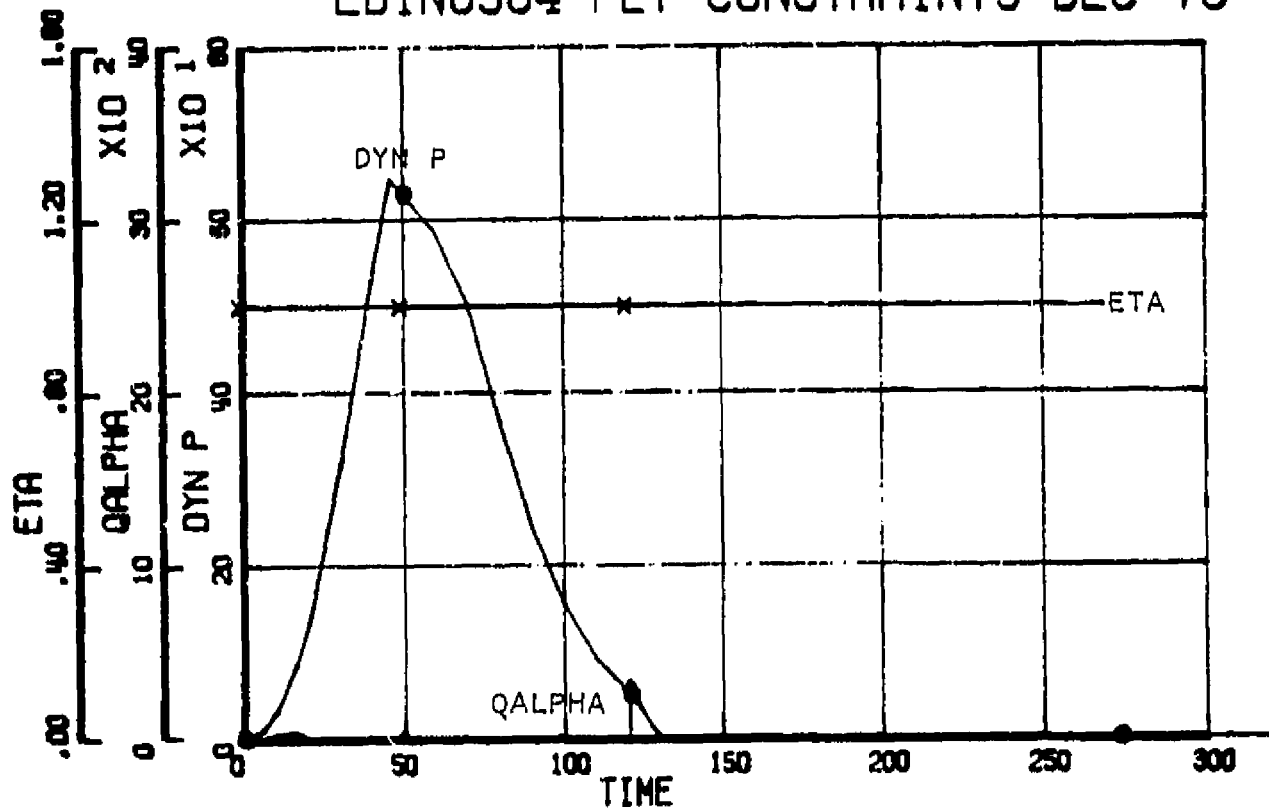
EDIN0504 LAUNCH STATE 16 DEC 75



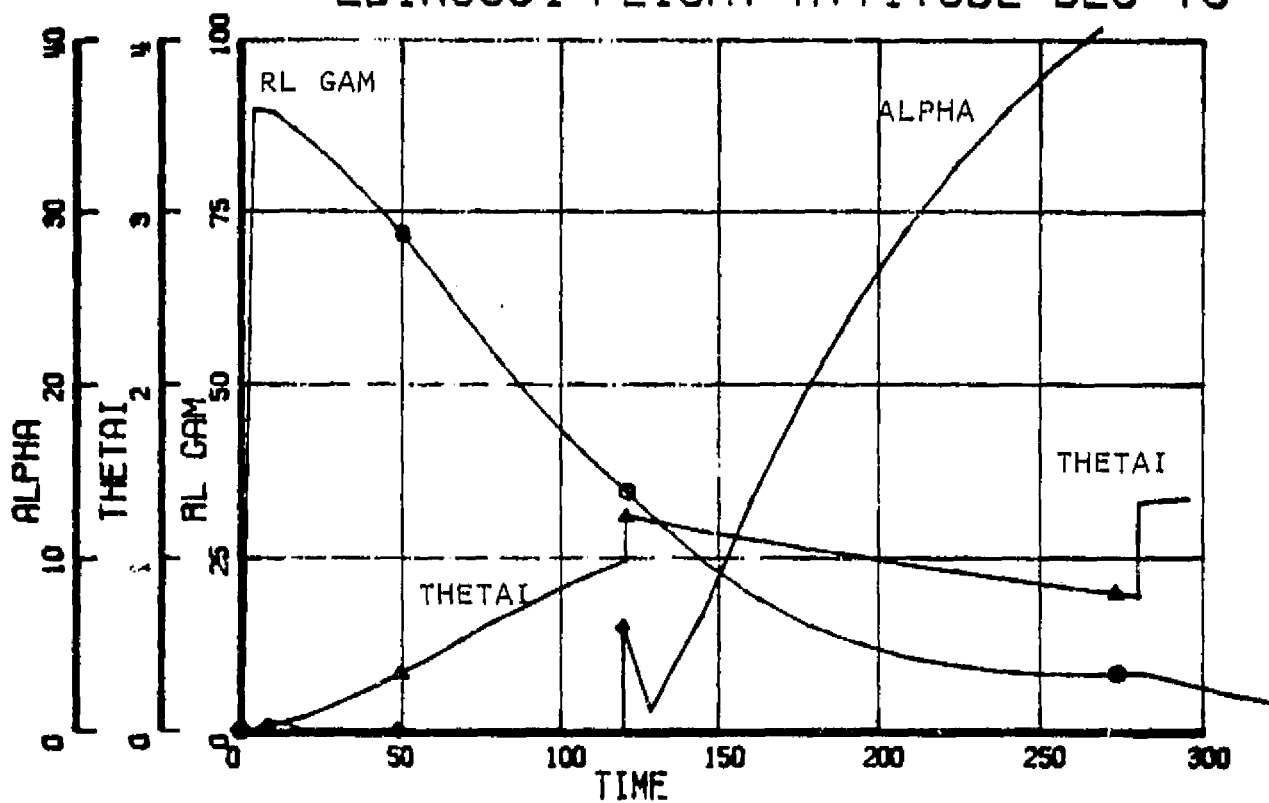
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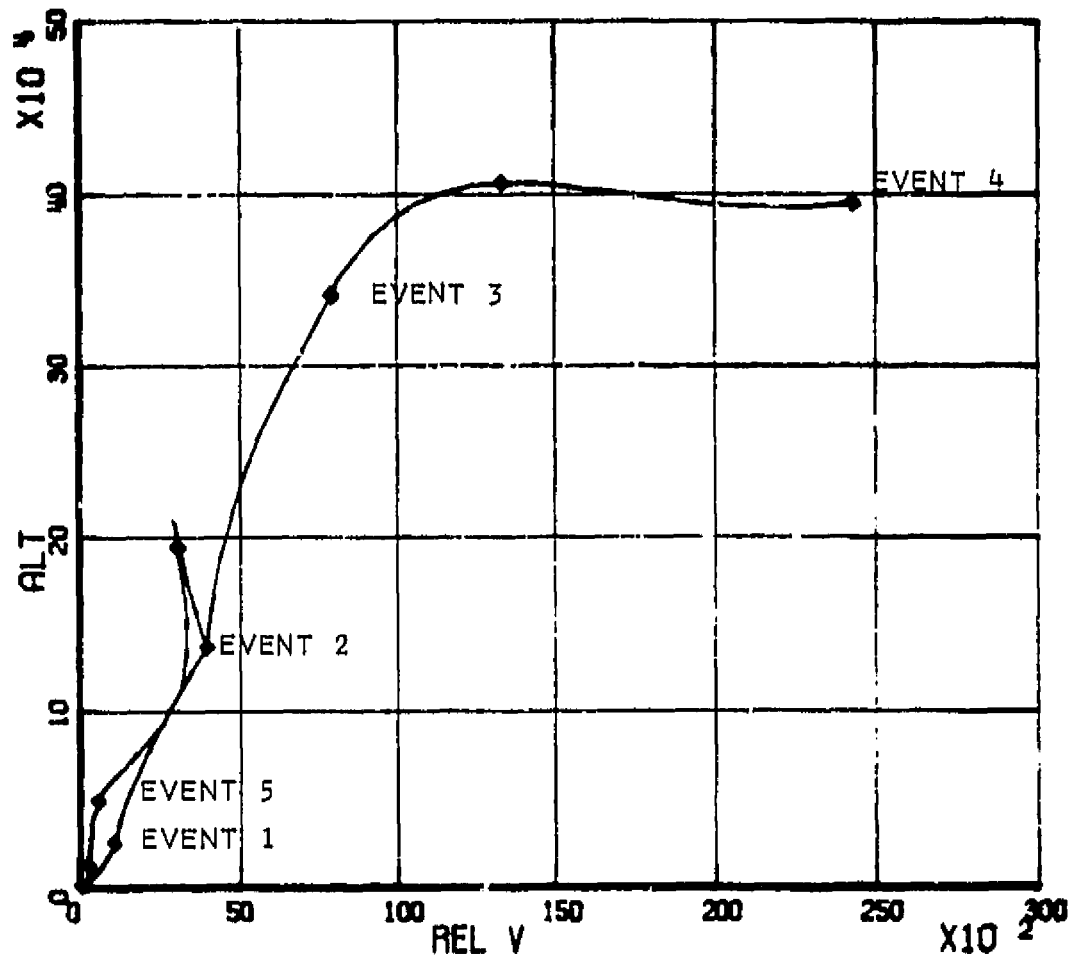
EDIN0504 FLT CONSTRAINTS DEC 75



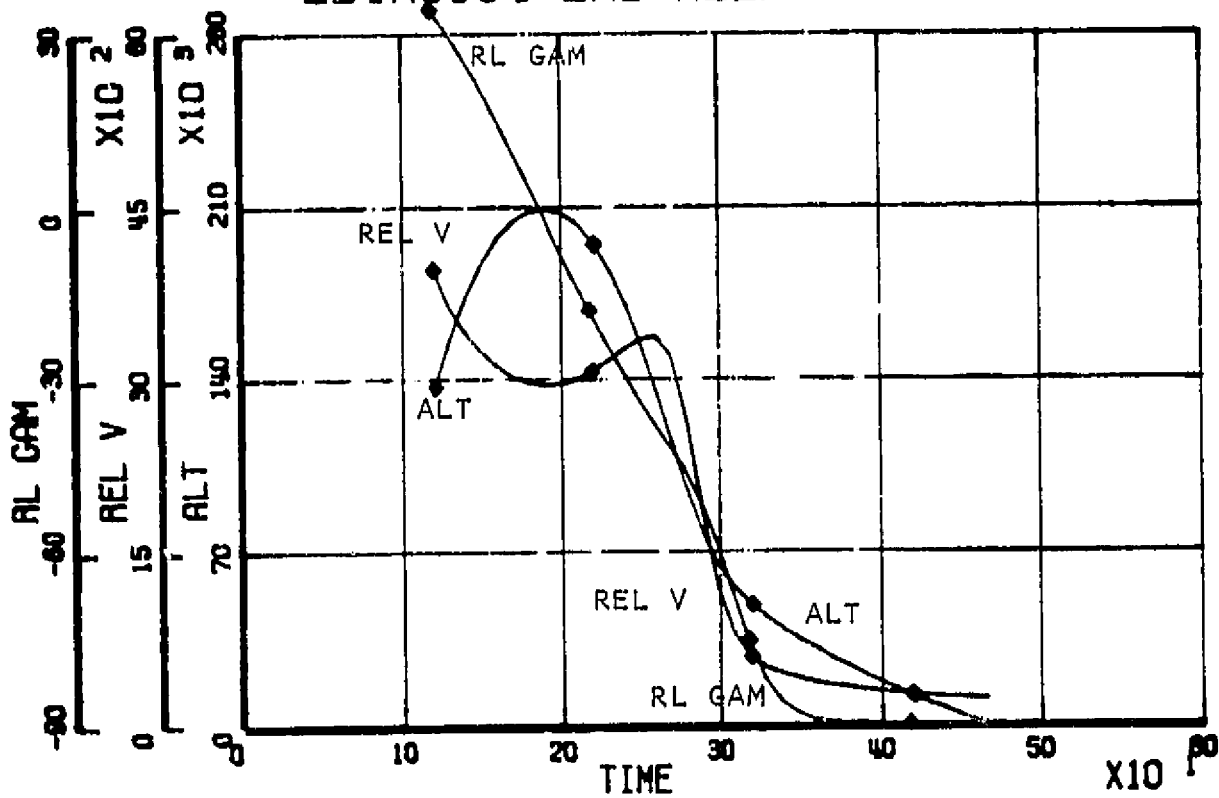
EDIN0504 FLIGHT ATTITUDE DEC 75



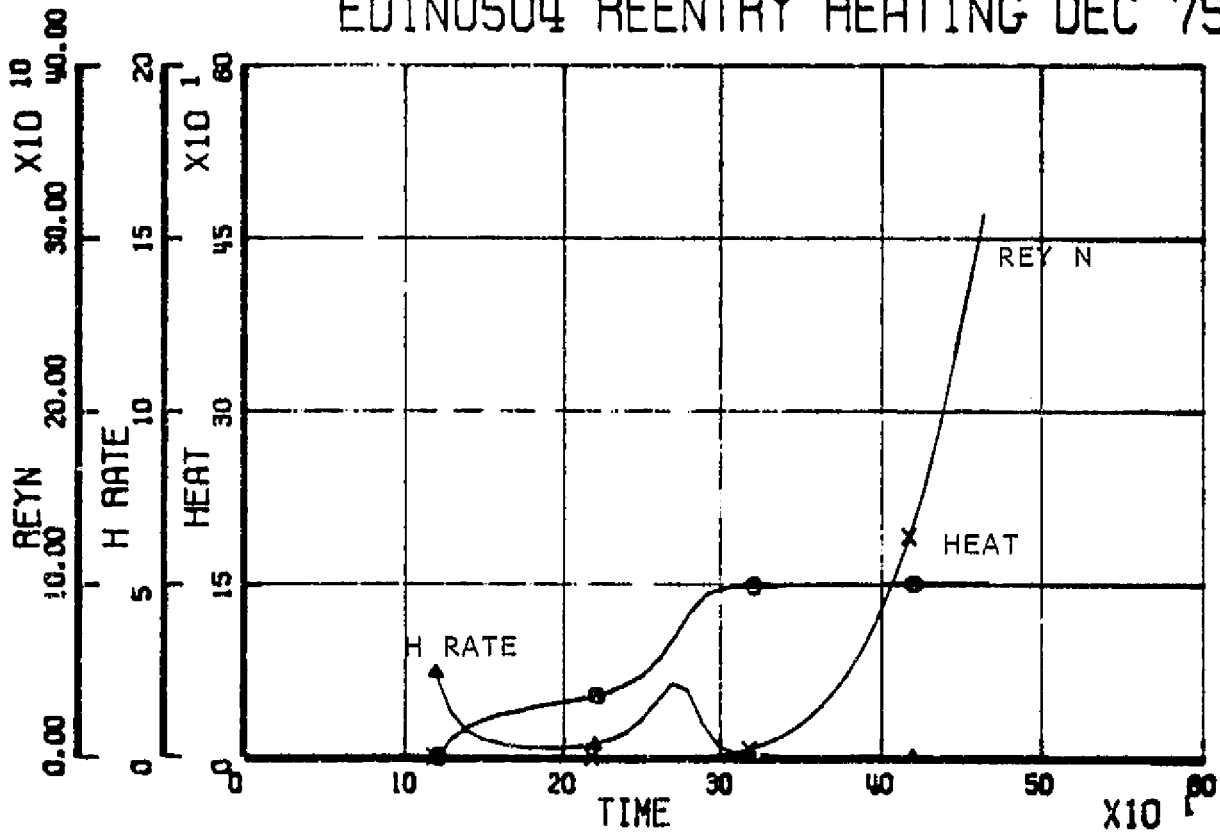
EDIN0504 H-V PROFILE 16 DEC 75



EDIN0504 LRB REENTRY STATE DEC 75



EDIN0504 REENTRY HEATING DEC 75



SIGMA CORPORATION

EDIN0505 DESIGN
SIMULATION RESULTS

 FORECASTER: EDIN DESIGN CENTER DATE: 24 NOV 75
 AFFILIATION: ENGINEERING ANALYSIS DIVISION/JSC TIME: 09:40
 STUDY NO: EDIN0505

CONCEPT: A 33.0 FT. DIAMETER RECOVERABLE STAGE USING 4.000 F-1
 ENGINES MOUNTED BEHIND THE SHUTTLE ET FOR REPLACEMENT
 OF THE SOLID ROCKET BOOSTERS.

MISSION: 100000.0 LB PAYLOAD
 DUE EAST LAUNCH FROM ETR
 A 250 FPS OMS DELTA VEL IN EXCESS OF A 50X100 NAUTICAL
 MILE REFERENCE ORBIT.
 A 100 FPS RCS TRANSLATION DELTA VEL.

TRAJECTORY: DUAL CONSTRAINT OPTIMIZED EXO-ATMOSPHERIC PITCH
 PROFILE AND INITIAL TILT RATE.
 MID POINT CONSTRAINT = SHUTTLE MISSION 1 RTLS/AOA
 END POINT CONSTRAINT = SHUTTLE MISSION 1 MECO
 ATMOSPHERIC INFIGHT CONSTRAINTS CONTROLLED BY ONE F1
 ENGINE SHUTDOWN AND/OR SOME THROTTLING.
 MAX DYNAMIC PRESSURE = 650.0 PSF
 MAX ACCELERATION = 3.0 G

PROPULSION: LRB: 4.000 F-1 ENGINES RATED AS FOLLOWS:
 THRUST(SL) = 1606788.5 LBS
 THRUST(VAC) = 1748060.0 LBS
 ISP(SL) = 266.01 SEC.
 ISP(VAC) = 289.40 SEC.
 FLOWRATE = 6040.3 LB/SEC
 EXIT AREA = 66.763 SQ FT
 MIX RATIO = 2.27:1
 ORBITER: THREE SSME ENGINES RATED AS FOLLOWS:
 THRUST(SL) = 375000.00 LBS
 THRUST(VAC) = 470000.00 LBS
 THROTTLE = 1.09 TO .500
 ISP(SL) = 363.20 SEC
 ISP(VAC) = 455.20 SEC
 FLOWRATE = 1032.5 LB/SEC
 EXIT AREA = 44.896 SQ FT
 MIX RATIO = 6.00:1

AERODYNAMICS: DATA FOR LAUNCH PERFORMANCE OPTIMIZATION
 WERE OBTAINED FROM SHUTTLE AERO ESTIMATES. ADJUSTMENTS
 WERE MADE TO THE REFERENCE AREA FOR SRB DELETION.
 REF AREA = 2557.0 SQ FT

STRUCTURE: ORBITER AND EXTERNAL TANK STRUCTURAL WEIGHT MODIFICATIONS
 ARE INCLUDED FOR DELETION OF THE SRB/ET ATTACHMENTS AND
 INCREASED UP PAYLOADS.

MASS
 PROPERTIES: MASS PROPERTIES ARE BASED ON THE FOLLOWING BASIC
 ASSUMPTIONS.
 LRB: WERS BASED ON SATURN TECHNOLOGY.
 ET: FIXED MASS FRACTION DISTRIBUTED IN
 ACCORDANCE WITH SHUTTLE ET WEIGHT
 STATEMENT.
 ORBITER: FEB 1975 SHUTTLE WITH MODS FOR
 INCREASED UP PAYLOAD.

ORBITER WEIGHT STATEMENT FOR MISSION 1:

WING GROUP	15684.	
TAIL GROUP	2962.	
BODY GROUP	43291.	
INDUCED ENVIRON PROTECT	19874.	
LANDING & AUX SYSTEMS	7683.	
PROPULSION-ASCENT	28054.	
PROPULSION-RCS	2657.	
PROPULSION-QMS	2902.	
PRIME POWER	2929.	
ELECTRICAL CONVERSION	6960.	
HYDRAULIC CONVERSION	1840.	
SURFACE CONTROLS	2739.	
AVIONICS	5778.	
ENVIRONMENTAL CONTROL	5060.	
PERSONNEL PROVISION	1100.	
PAYLOAD PROVISIONS	585.	
MARGIN	1327.	
WT PENALTY FOR 100K PAYLD	390.	
ORBITER EMPTY WEIGHT		151715.
PERSONNEL	2644.	
RESIDUALS	1470.	
RESERVE FLUIDS	1840.	
INFLIGHT LOSSES	2171.	
ASCENT PROPULSION	5024.	
PROPELLANT-RCS	6241.	
PROPELLANT-QMS	16149.	
ORBITER INERT WEIGHT		187254.
PAYLOAD		100000.
ORBITER PRELAUNCH WEIGHT		287254.

EXTERNAL TANK WEIGHT STATEMENT:

LOX TANK		11897.
BHD	58.	
FWD FRAME	37.	
FWD OGIVE	982.	
AFT OGIVE	3301.	
XT 745 FRAME	229.	
BARREL	2134.	
INTERTANK FRAME	779.	
AFT DOME	2538.	
SLOSH BAFFLES	1839.	
INTERTANK		9298.
MACHINED BARREL PNLS	3723.	
SK/STGR BARREL PNLS	4024.	
STABILIZING FRAMES(4)	1101.	
SRB THRST XT 985 FRAME	0.	
SRB THRST BEAM	0.	
SRB THRST FITTINGS (2)	0.	
ACCESS DOOR	50.	
BARREL PNLS SPLICES (8)	82.	
FRAME STABLIZERS	178.	
ET ASSY FASTENERS	139.	

LH2 TANK		29187.
FWD DOME	1392.	
XT 1129.9 FRAME	1374.	
BARREL NO.4	4774.	
XT 1377 FRAME	479.	
BARREL NO.3	4800.	
XT 1624 FRAME	479.	
BARREL NO.2	4802.	
XT 1871 FRAME	1504.	
BARREL NO.1	5079.	
XT 2058 FRAME	2875.	
AFT DOME	1628.	
THERMAL PROTECTION		5655.
LOX TANK	1213.	
INTERTANK	1259.	
LH2 TANK	2954.	
PROP (MECH+ELEC)	230.	
PROPULSION AND MECHANICAL SYSTEMS		3295.
LOX FEED SYS	1409.	
LOX ANTIGEYER SYS	132.	
LOX VENT SYS	74.	
LOX PRESS. SYS	160.	
LH2 FEED SYS	403.	
LH2 RECIR. SYS	26.	
LH2 VENT SYS	112.	
LH2 PRESS. SYS	119.	
HELIUM INJ. SYS	18.	
INTERTANK PURGE SYS	70.	
HAZARD GAS DETECTION SYS	7.	
FAIRINGS AND CONDUIT	298.	
LINE SUPTS. AND ATTACHS.	466.	
ELECTRICAL SYSTEM		204.
ET WIRING ASSY	138.	
SRB WIRING ASSY	0.	
INSTRUMENTATION	13.	
CABLING ATTACHS.+SENSOR SUPTS.	53.	
ORB/SRB ATTACHMENTS		3920.
ORBITER SUPPORTS	2690.	
UMBILICAL BEAM	552.	
ORB/ET ATTACH FTGS	205.	
SRB/ET ATTACH FTGS	0.	
ET/ORB UMBILICAL HDWR	474.	
MANUFACTURING VARIATION WT.		370.
EMPTY WEIGHT		63827.
UNUSABLE FLUIDS		356.
LH2 IN TANK	200.	
LH2 IN LINE	41.	
LOX IN LINE	115.	
PRE-PRESS.+INFLIGHT GASES		3223.
GH2	838.	
GOX	2358.	
HELIUM	27.	
SEPARATION HARDWARE		4.
SRB SUPPORTS	0.	
ORB FITTINGS	4.	
FLT PERF RES		5574.
ET INERT WT		72985.
MAIN PROPELLANTS		1249368.
LOX	1070867.	
LH2	178481.	
ET LIFT-OFF WEIGHT		1322353.
MASS FRACTION		.9490

LIQUID ROCKET BOOSTER WEIGHT STATEMENT:

BODY STRUCTURE		69663.
INTEGRAL LOX TANK	24101.	
INTEGRAL FUEL TANK	16337.	
INTERSTAGE	8583.	
AFT SKIRT	16159.	
THRUST STRUCTURE	4482.	
AERODYNAMIC SURFACES		6916.
STABILIZERS (DRAG FLAPS)	6916.	
THERMAL PROTECTION SYSTEM		2305.
TANK INSULATION	941.	
ABLATIVE MATERIAL	1364.	
POWER SUPPLY/CONVERSION/DISTRIBUTION		873.
ELECTRICAL SYSTEM	748.	
CONTROL SYSTEM	126.	
INSTRUMENTATION SYSTEM		1520.
INSTRUMENTATION	1520.	
PROPULSION		114948.
ENGINES (DRY)	76152.	
ACCESSORIES	555.	
GIMBAL SYSTEM	7044.	
BASE HEAT SHIELD	4356.	
FUEL SYSTEM	11185.	
OXIDIZER SYSTEM	15656.	
SEPARATION AND RECOVERY SYSTEM		16847.
SEPARATION SYSTEM	2488.	
CHUTE SYS (MAIN AND DROGUE)	5836.	
FLOTATION SYSTEM	106.	
RECOVERY AIDS	104.	
FITTINGS AND SUPPORTS	201.	
RETRO SYS (100 F/S DEL V)	3236.	
REENTRY HEAT SHIELD	4876.	
STAGE DRY WEIGHT		213072.
CONTINGENCY		0.
EMPTY WEIGHT		213072.
PROPELLANT RESIDUALS		46991.
FUEL BIAS	1800.	
TRAPPED LOX TANK GASES	4511.	
TRAPPED FUEL TANK GASES	4008.	
FROST TRAPPED	505.	
TRAPPED FUEL	15103.	
TRAPPED LOX	21064.	
IN-FLIGHT LOSSES		5027.
FUEL LOSSES	2429.	
LOX LOSSES	2597.	
LRB INERT WT		265090.
MAIN PROPELLANTS		2920477.
FUEL	893112.	
LOX	2027365.	
BLOW		3185567.
MASS FRACTION (BASED ON INERT WEIGHT)		.91678

ORBITER WT	287254.0
ET WEIGHT	1322353.4
LRB WEIGHT	3185567.2
GLOW	4795174.5
STG 1 LAMBDA	.91678
STG 2 LAMBDA	.94481

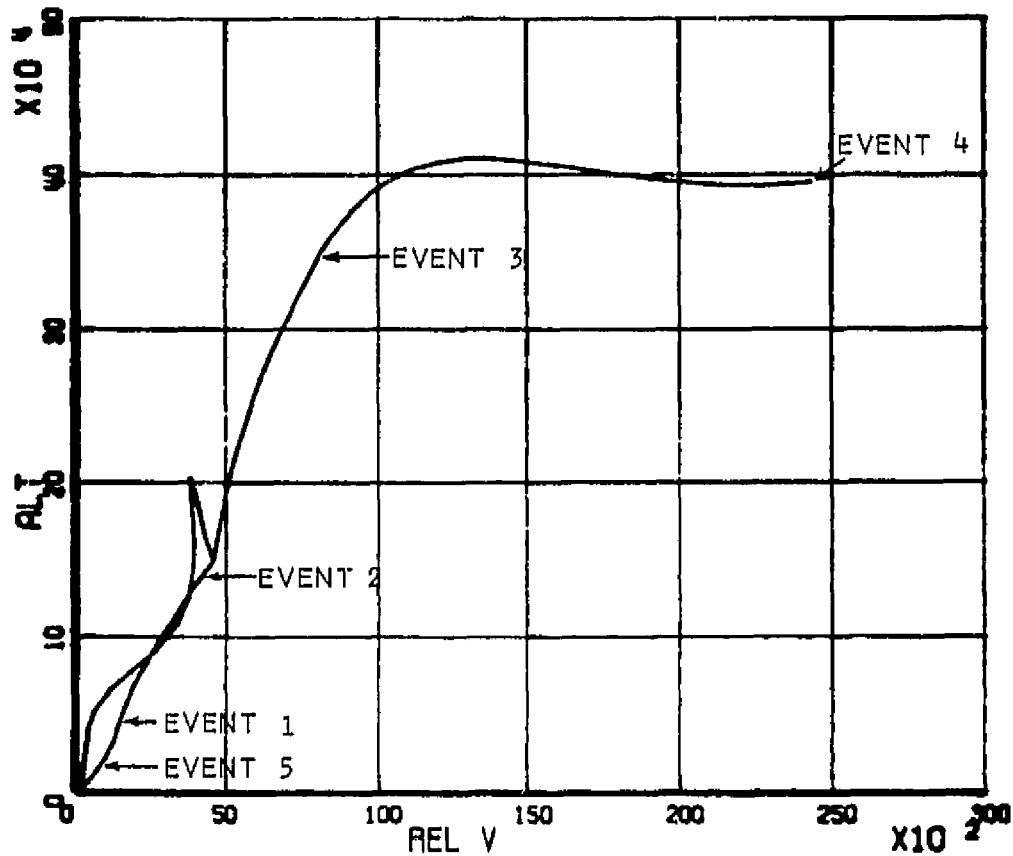
GLW	4735174.	
TARGET PAYLOAD	100000.	
ACTUAL PAYLOAD		100363.
PAYLOAD DELTA		362.7
TOTAL VIDEAL	30434.1	
STAGE 1 VIDEAL		8510.5
STAGE 2 VIDEAL		21923.6
TOTAL PROPELLANT	4169554.	
LPB PROPELLANT		2918701.
ET PROPELLANT		1250853.
FIRST STAGE JETTISON WT		264929.
SECOND STAGE JETTISON WT		73075.

STAGE 1 LIFTING DATA	
AVERAGE SP. IMP.	281.93
LIFT-OFF T/W	1.340
MAXIMUM Q	651.5
TIME AT MAX Q	62.5
STG 1 MAX LF	2.78
TIME AT MAX LF	140.0

WEIGHT	1876473.
REL VELOCITY (FPS)	4577.8
REL F.P. ANGLE (DEG)	24.39
ALTITUDE (FT)	149411.
TIME (SEC)	140.24
ATT AFTER STG (DEG)	.87

• GLOW		4795174.50
• ET LIFT-OFF WEIGHT		1322353.36
•		
ET INERT WEIGHT	72985.36	
ET PROPELLANT	1250852.73	
•		
LRB LIFT-OFF WEIGHT		3185567.19
•		
LRB INERT WEIGHT	265090.01	
LRB PROPELLANT	2918700.84	
•		
ORBITER LIFT-OFF WEIGHT		287254.00
•		
ORBITER INERT WEIGHT	187254.00	
PAYLOAD	100000.00	

EDIN0505 H-V PROFILE 24 NOV 75

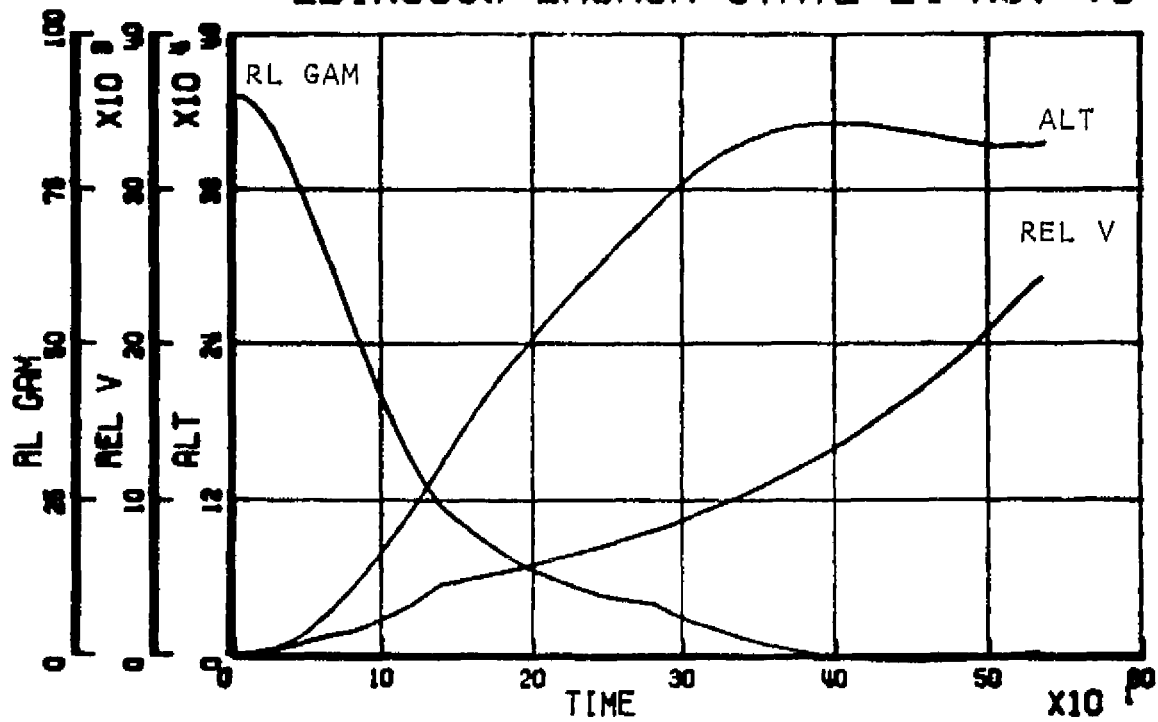


MISSION SUMMARY: NOVEMBER 24, 1975

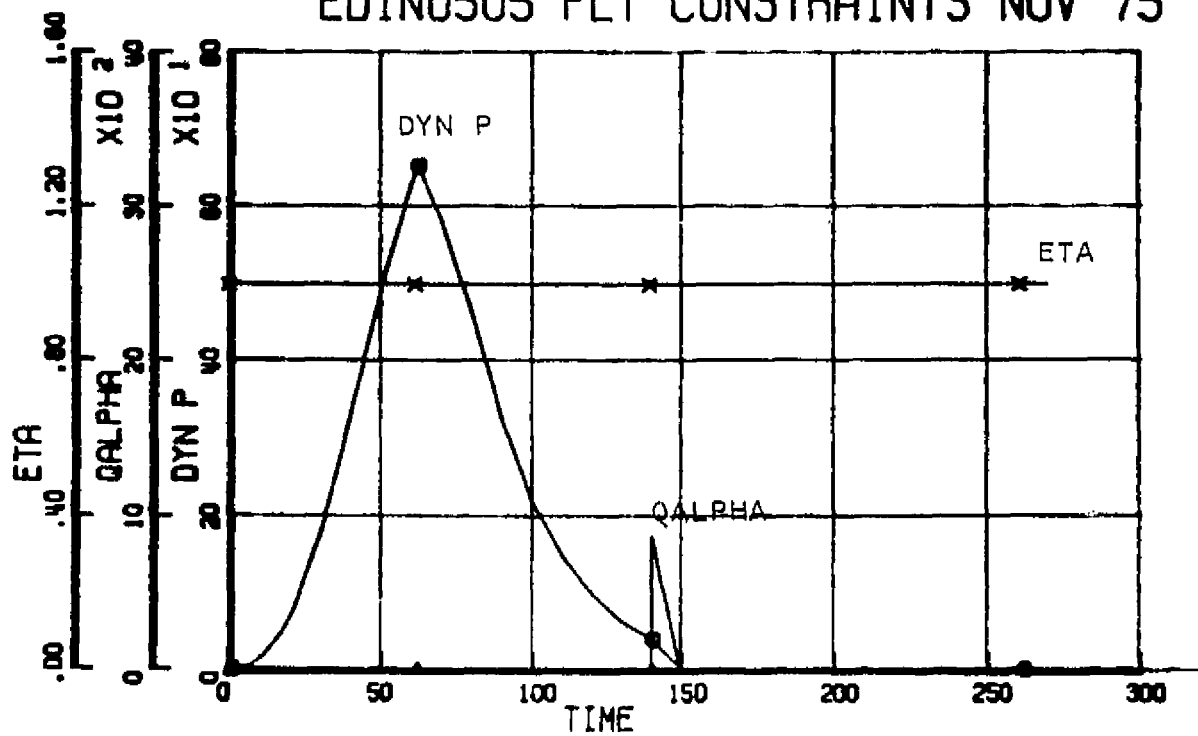
PARAMETER	EVENT 1	EVENT 2	EVENT 3	EVENT 4	EVENT 5
TIME (SEC)	62.50	140.2	283.8	536.0	490.0
ALTITUDE (K FT)	30.75	149.4	348.6	394.5	0
REL VELOCITY (100 FPS)	12.2	45.8	81.4	243.0	2.15
REL GAMMA (DEG)	66.6	24.4	8.27	.527	-89.8
WEIGHT (K LBS)	4795.2	3285.1	1611.5	1126.9	264.9
WEIGHT DROP (K LBS)	0	264.9	0	73.08	0
THROW WEIGHT (K LBS)	3285.1	1611.5	1126.9	287.62	0
CUM VIDIAL (100 FPS)		85.10		304.3	0
DOWNRANGE (NMI)	1.38	28.97	187.7	865.3	136.0

EVENT 1 ONE F-1 ENGINE SHUTDOWN
 EVENT 2 BECO/SEPARATION
 EVENT 3 RTLS/ROA CONSTRAINT
 EVENT 4 MECO/INJECTION
 EVENT 5 LRB TOUCHDOWN

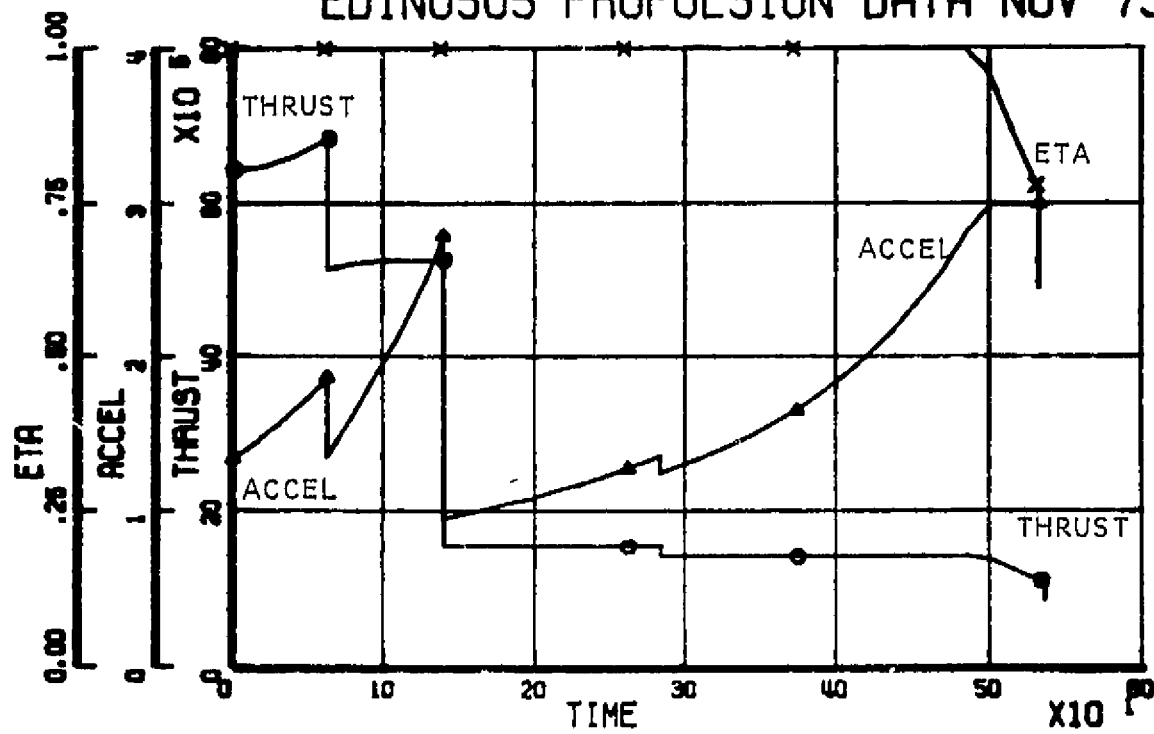
EDIN0505 LAUNCH STATE 24 NOV 75



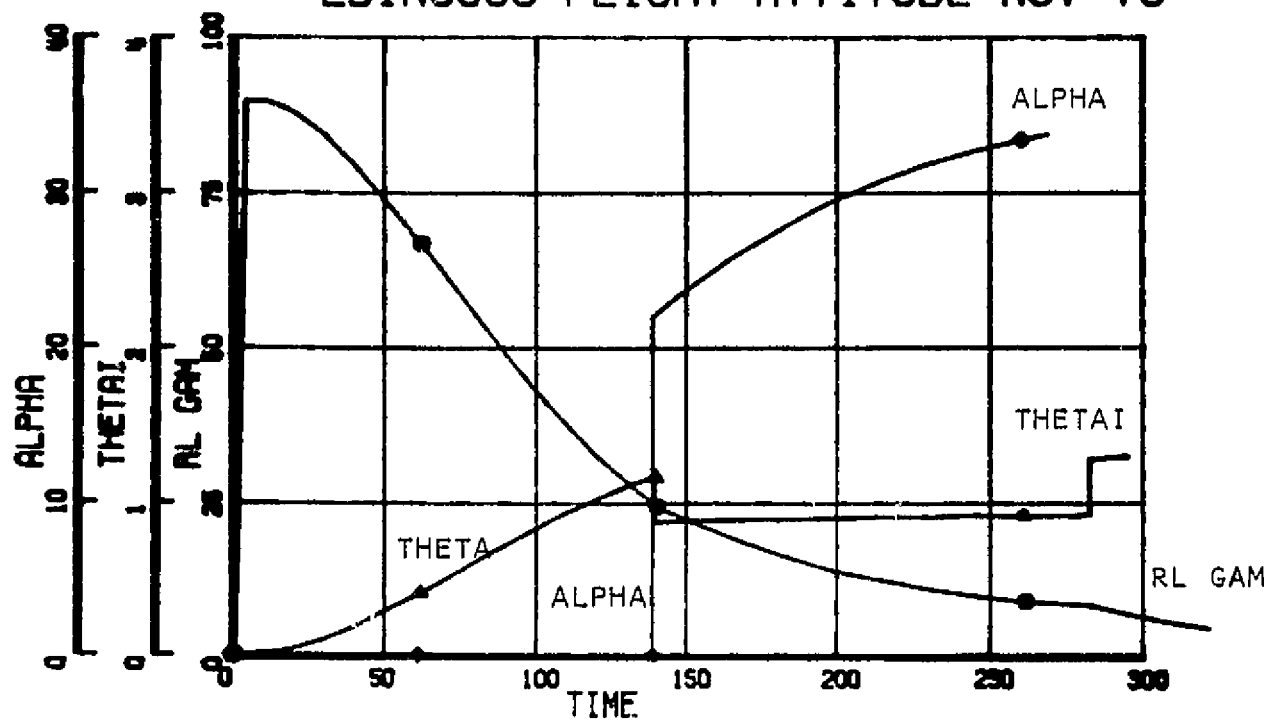
EDIN0505 FLT CONSTRAINTS NOV 75



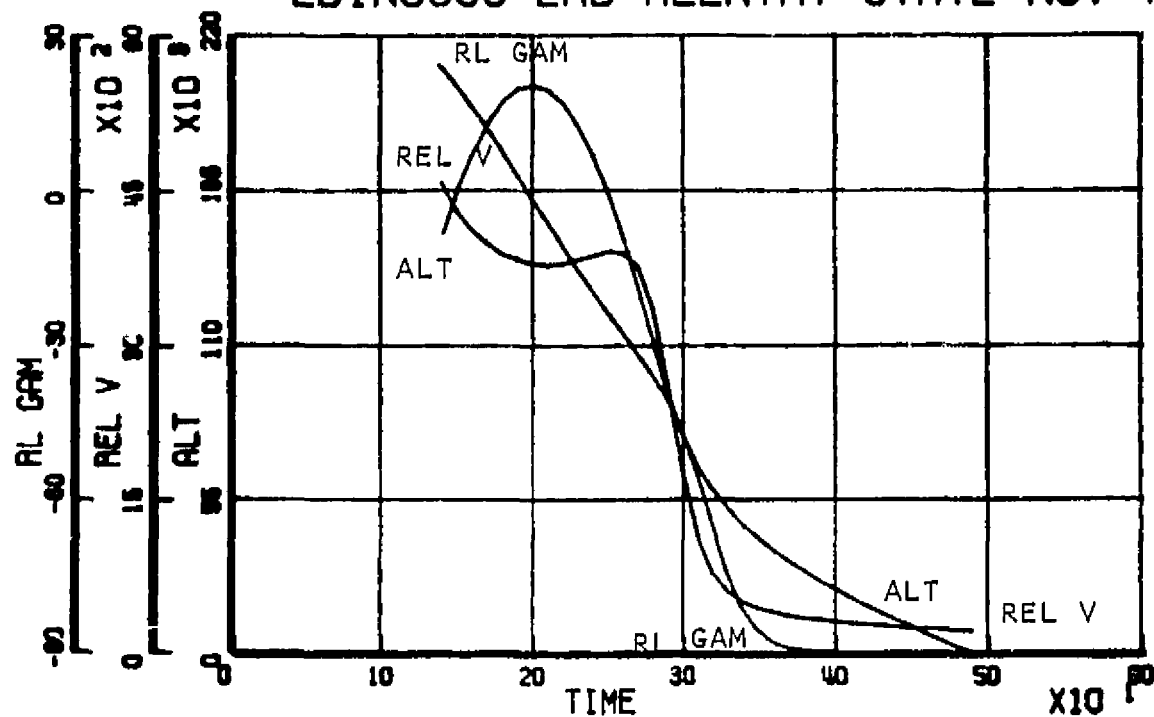
EDIN0505 PROPULSION DATA NOV 75



EDIN0505 FLIGHT ATTITUDE NOV 75



EDIN0505 LAB REENTRY STATE NOV 75



EDIN0505 REENTRY HEATING NOV 75

